AUG

Heating · Piping and Air Conditioning

August, 1930

Articles on

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SAMUEL R. LEWIS

Piping—
By A. H. BEILER *and*
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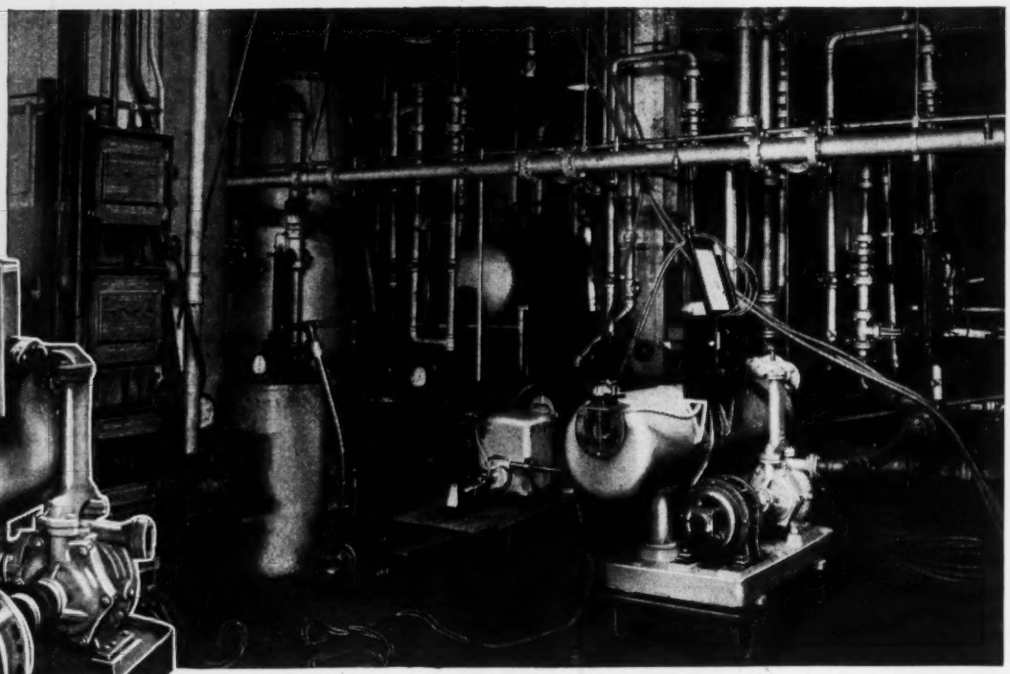
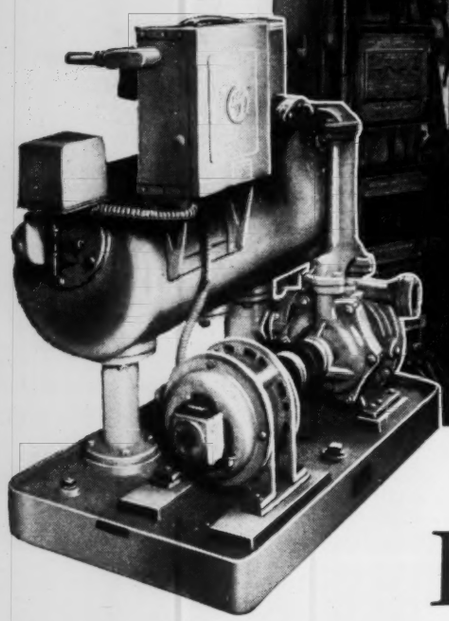


Corner of laboratory in Nash Factory where every Jennings Pump is carefully tested.



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Bulletin 85 describes the design and operation of the Jennings Vacuum Heating Pump. Write for a copy.

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Heating · Piping and Air Conditioning

Vol. II August, 1930 No. 8

Many Applications *for the* Direct Fired Hot Blast System in Schools, Public *and* Industrial Buildings

By Platte Overton*

THE modern, well-designed, direct-fired unit for fan blast systems of heating and ventilating will give efficient service for many years.

The direct-fired, hot blast system, being low in initial cost also may be the answer for the architect or designing engineer to such problems as lack of funds, poor water or a limited supply, lack of licensed engineers, or other unforeseen conditions that place other systems out of reach.

FIG. 1—TEMPERATURE IN THE TEMPERED AIR CHAMBER IS MAINTAINED BY MEANS OF DAMPERS IN THE BYPASS. (SECTION B-B OF FIG. 2)

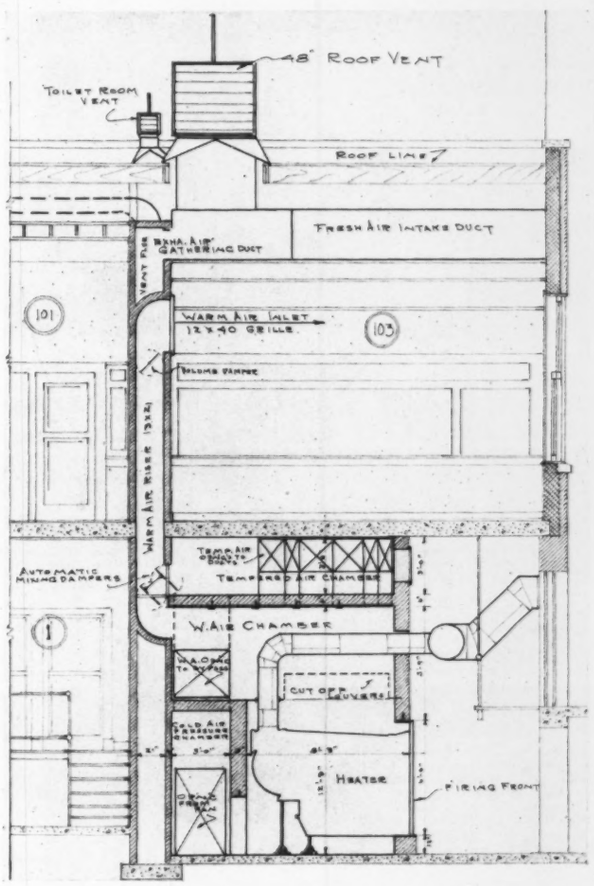
Application to a High School

It will be of interest to describe the installation of a direct fired hot blast system in a school. The state ventilation code, in this case, called for 100 per cent outside air while the building was occupied, but provision was made in the attic exhaust ducts to recirculate 100 per cent of the air when the building was being warmed up before school.

A manually operated switch in the basement marked "Fresh air" and "Recirculation" controls the various attic dampers. When the recirculation dampers are opened, the fresh air and roof vent dampers are closed. When 100 per cent outside air is supplied, the recirculation dampers are closed, and the fresh air and roof ventilator dampers are opened.

With the warm air blast system, outside air is drawn in by the fan and forced over the direct-fired heaters, then into the warm air or plenum chamber. Over this chamber is located a second chamber containing tempered air at 65 to 70 degrees. The temperature is maintained by dampers in the bypass as shown in Fig. 1. Cut-off dampers are placed over each heater, making it possible to cut off one or more heaters in mild weather.

The necessary ceiling height to provide the tempered



*Consulting engineer, Chicago.

air plenum chamber over the warm air plenum is not always available. In this case, the tempered air space may be placed on either side of the heater casings or in the rear, or completely around the heaters. This tempered air chamber may be built of brick, or galvanized iron.

The mixing dampers in the ducts are actuated by individual thermostats in each room. As the temperature falls, the warm air leaf is opened, closing the tempered air and as it rises, the tempered air leaf opens, closing the warm air.

Gradual-action mixing dampers are important. In the event that the tempered or cold air chamber is not heated

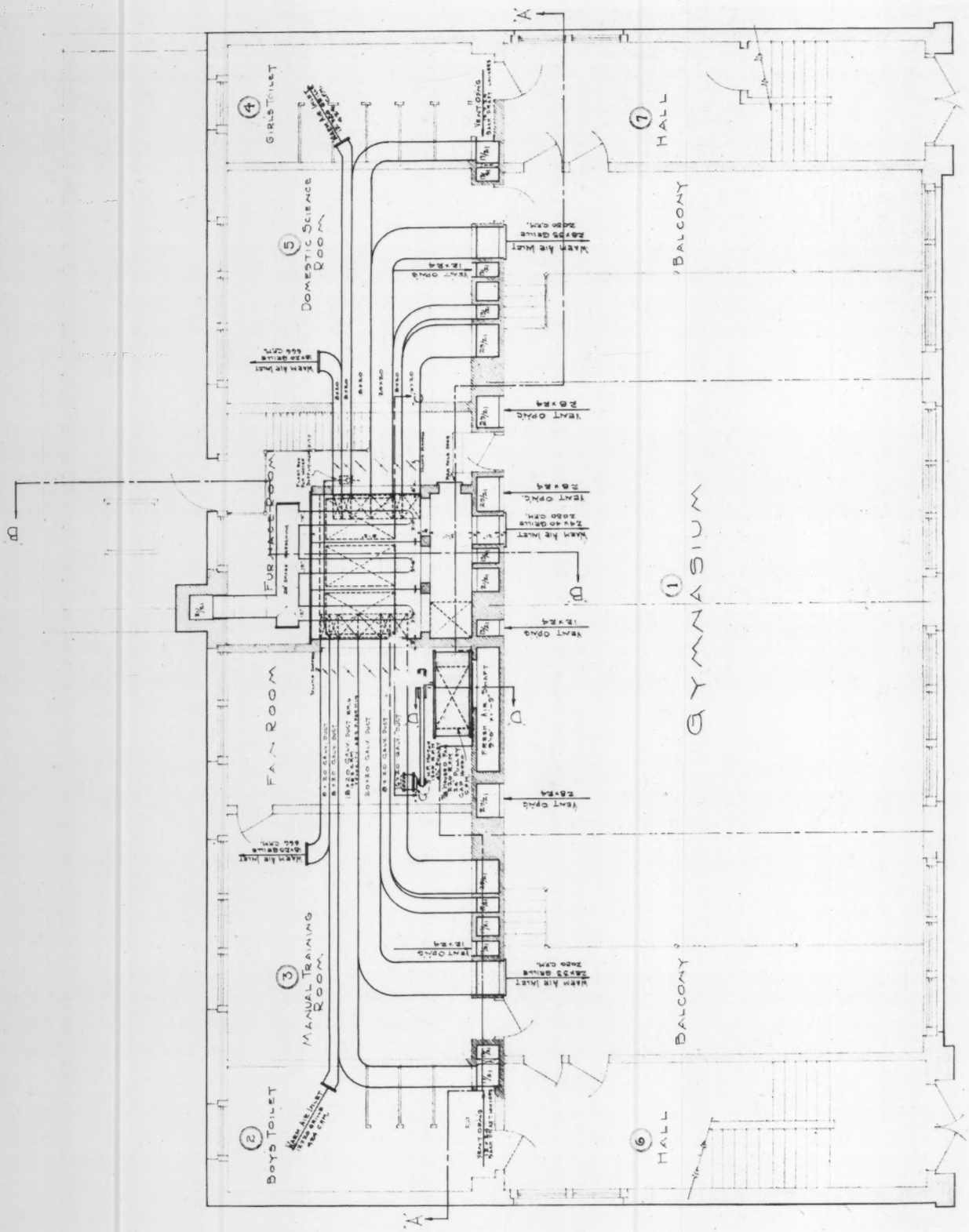


FIG. 2—GROUND FLOOR PLAN OF A SCHOOL HEATED AND VENTILATED WITH A FAN BLAST SYSTEM

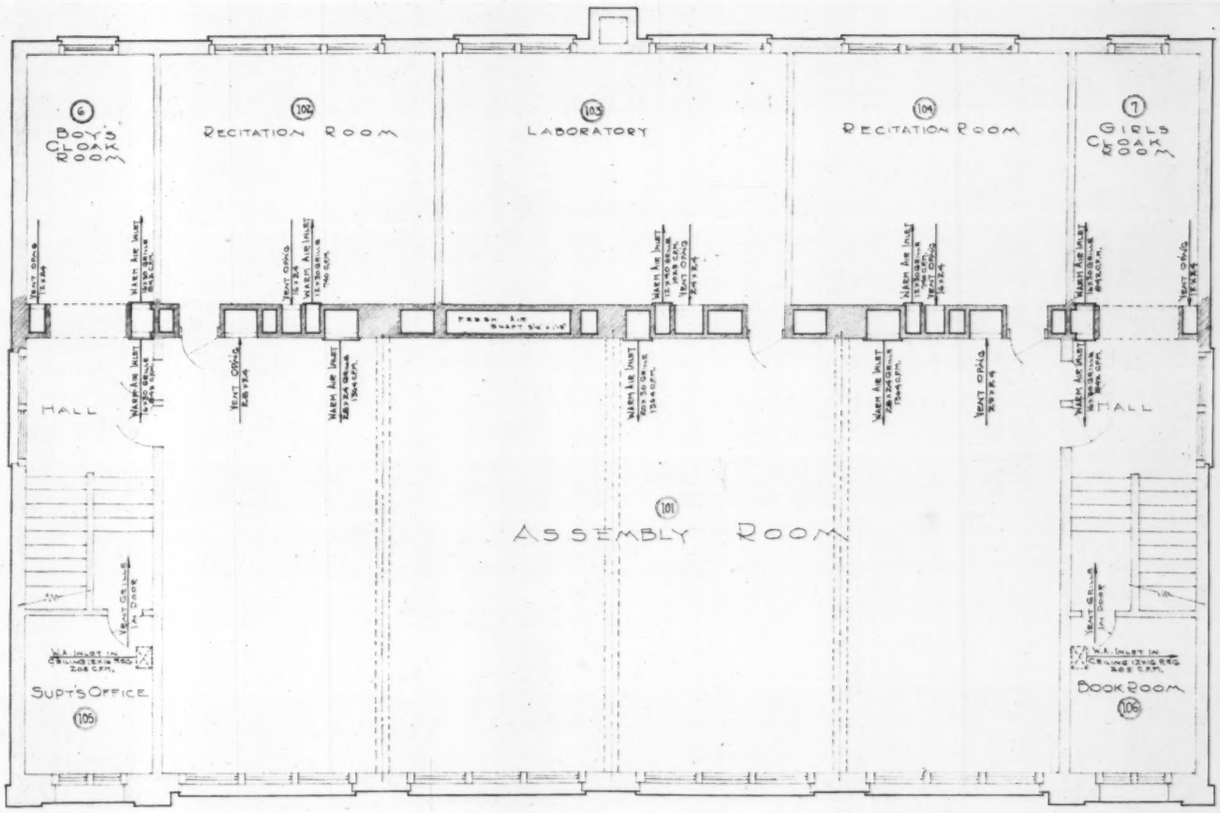


FIG. 3—FIRST FLOOR PLAN

or tempered by warm air from the warm air plenum, the gradual action type of mixing damper is a necessity. Many failures of the direct fired system of hot blast heating have been directly traced to the antiquated positive action mixing damper. Here it readily can be seen that when the thermostat shifts the position of the mixing damper to supply cooler air, a stream of air too cold for comfort may strike the occupants before it reaches the thermostat. With the gradual control action type, the two damper blades will cause a positive mixture of the cold and warm air. Automatic bypass louvres are installed in the fan discharge duct to allow gravity service over the heaters when the fan is not running.

The Maintenance of Humidity

Humidity is maintained by the installation of water pans in the plenum chambers with an automatic feed actuated by a humidostat in the assembly room. These pans have an area of 100 sq. in. for every 1000 cu. ft. of air supplied.

Velocities in Ducts

The supply ducts are designed for a velocity of 600 to 750 f. p. m. These velocities vary as all ducts are 20 inches deep for the sake of appearance and no duct is less than 8 inches wide, if 20 inches deep.

Brick risers are designed for a velocity of 500 f. p. m., but those directly connected to the warm air chamber are made smaller due to there being less resistance.

The warm air inlets are designed for a velocity of 250 to 300 f. p. m.; exhaust or vent flues are sized for a gravity velocity of 300 f. p. m. In the school laboratory the vent flue is increased to exhaust more air than is supplied, as odors will permeate the adjacent rooms if we do not maintain an "in" draft when hall doors are opened.

This installation is a good example of the practical application of the rule that inlets and outlets should be placed on the same wall, namely, the inside wall. The proper diffusion of air is then assured.

The average inlet temperature at the grille is 105 degrees, and varies from 84 to 120 degrees in the various rooms. The air supply in all cases is fixed by the code.

Procedure When School Is Not in Session

For service during the time that school is not in session, the fires are banked and a gravity supply through the gravity bypass keeps the various rooms at a temperature well above freezing.

As the temperature at the fan intake is never constant, the air supplied will vary somewhat in volume, but the fan is based on volume to be supplied at the mean outside temperature for the heating season.

The apparent over-supply of air in the gymnasium is the result of a very stringent ventilation code calling for 3 cu. ft. per sq. ft. of floor area, as this room is also used for public gatherings of the community.

Galvanized ducts were left exposed and painted. An indicating thermometer was placed in the front wall of the plenum chamber. This thermometer keeps the fireman posted, and after a few days of service he knows at what temperature the plenum chamber must be maintained. This temperature will vary with the outside tem-

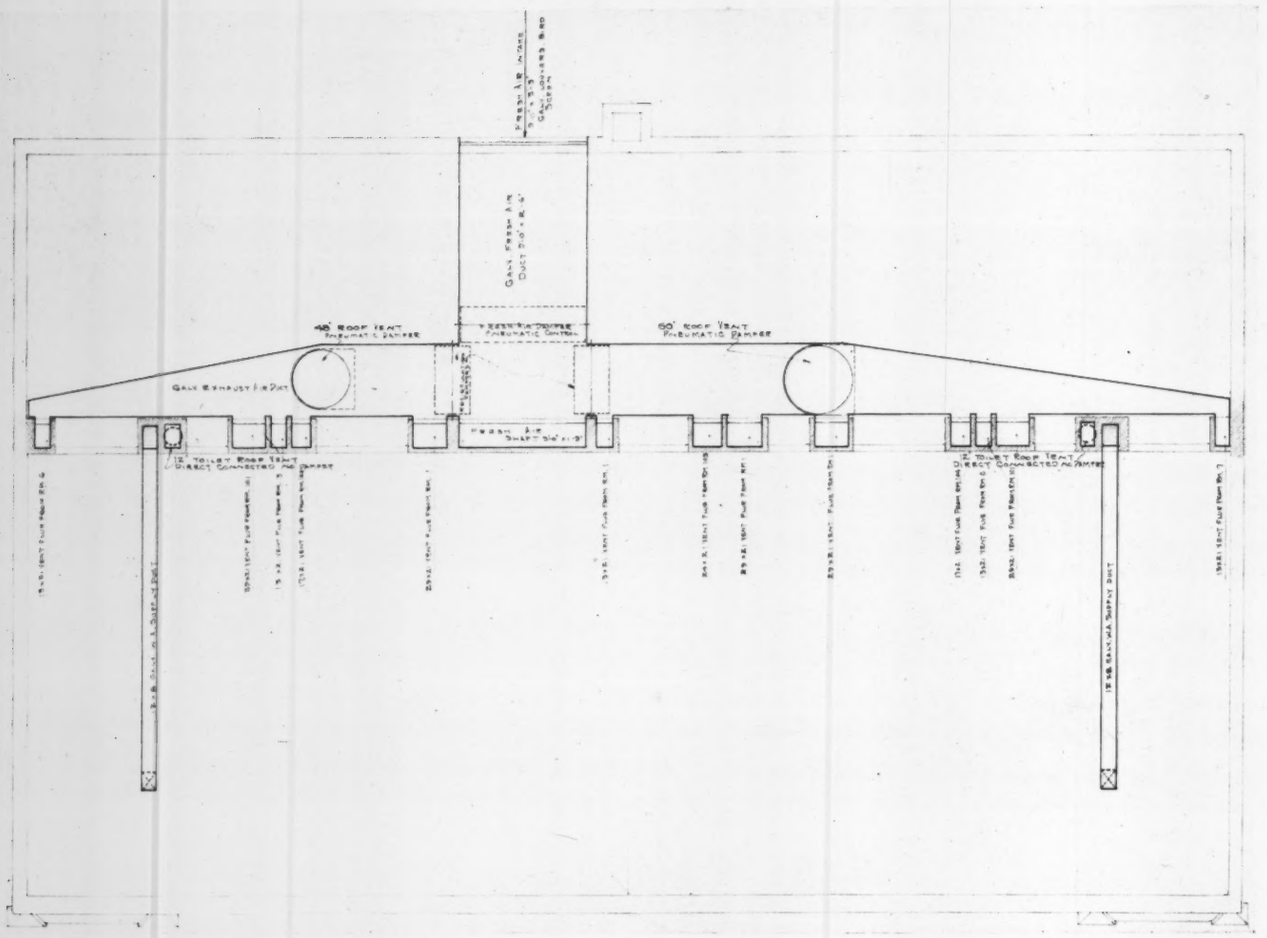


FIG. 4—ATTIC AND ROOF PLAN

perature, but should never be in excess of 125 degrees, except in the early morning firing.

A hot water coil was installed for service for a 100-gal. tank for showers and lavatories. Three horizontal heaters with 8 sq. ft. of grate surface each were installed. The requirements were 21 sq. ft.

No provision is made for dust removal for this installation; however, the outside air intake is high and on the side of the building in preference to the roof.

Toilet vent flues are direct-connected to roof ventilators without dampers, and the exhaust grilles from these rooms are equipped with back draft louvres.

In some cases school authorities may demand a higher humidity than is possible with this installation. The water pans used will fall short of providing evaporation of nearly one gallon of water per minute which would be ideal for the building with the outside temperature at 0 degrees or below.

The installation of an air washer between the fresh air shaft and the fan intake with approximately 75 per cent recirculation of the exhaust air from the rooms not contaminated by other than human occupancy would have made an ideal installation and one heater could have been eliminated.

The features of the direct fired hot blast system here shown are simplicity, and efficiency. Thermal efficiencies as high as 71 per cent have been observed on such systems, and while building construction and other physical conditions often reduce this efficiency to a lower figure, the direct fired system can show a performance record that is comparable to other systems.

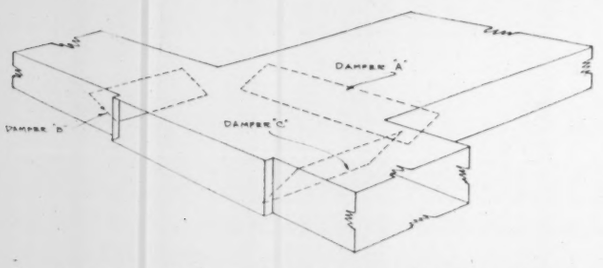


FIG. 5—FRESH AIR AND RECIRCULATING DAMPERS. DAMPER *A* OPEN WHEN DAMPERS *C* AND *B* ARE CLOSED

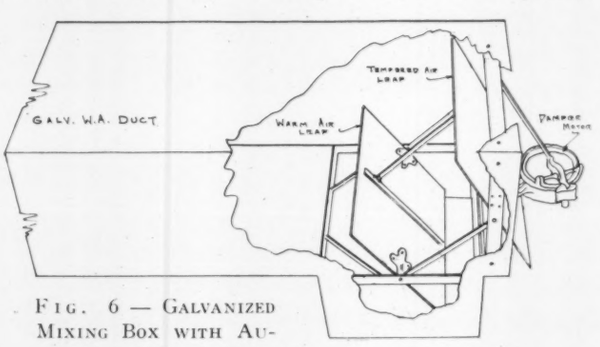


FIG. 6 — GALVANIZED MIXING BOX WITH AUTOMATIC DAMPERS

Economical Steam Pipe Sizes *for* Heating, Process and Power Steam

Article No. 1

By A. W. Moulder*

With the tables published with this article (and those to appear in other installments of this series) it is possible to figure steam pipe sizes for heating, industrial and power installations on the basis of approaching the theoretically correct size just as closely as practical experience warrants. Theory is made secondary to practicality; absolute accuracy to real usability.

These tables have been used by a large manufacturing and engineering concern with extremely satisfactory results. You will want to use them, as they strike the sought-after balance between "result-giving theory" and "time-saving practice."

SOMEBODY once described a German daschund as "a dog and a half long and half a dog high." It's about the same thing with steam pipe sizes. If they are determined with absolute accuracy on a theoretical basis from technical text books on this subject, the cost of the detailed engineering expense is often out of proportion to the savings in first cost and operating efficiency.

If, on the other hand, steam pipe sizes are always determined by ordinary "rule-of-thumb" methods, the large factor of safety necessitated by such methods results in useless waste in first cost plus, usually, a sacrifice in operating efficiency.

What the engineer and contractor wants for the ordinary heating or process steam job is a regular dog—not one too long on theory, or one too short on practicality or vice versa—just a nice useful mongrel with the right parts of theory and practice.

It is the purpose of this and subsequent articles to outline in detail methods of arriving at *economically* correct pipe sizes which, after all, is nothing more than making theory practical—putting the laboratory into the field.

Comparison of "Textbook," "Rule-of-Thumb" and "Practical" Methods

There are many textbooks, containing charts or tables of steam pipe capacities, together with descriptions of their use which enable the engineer to produce theoretically correct steam pipe sizes for every given definite condition. Such tables, charts and methods, however, are used only by a few engineers for figuring steam pipe sizes and then only on jobs of an extraordinary nature. For the ordinary steam job the engineering involved is too tremendously detailed to warrant the engineering expense required for such elaborate calculations.

On the other hand, from these most excellent textbooks, there have been evolved many steam pipe size tables of the so-called rule-of-thumb type. From these a steam pipe size can be picked out almost at a glance. Such tables are used by the majority of engineers and contractors upon whom devolve the responsibility of choosing pipe sizes for heating and many of the other more common forms of steam piping. Necessarily, these methods are usually on the safe side, resulting in relatively low total pressure drops and large pipe sizes and therefore are productive of waste not only in first cost, but in many cases waste in heat loss by radiation from the pipes.

Aside from the question of waste is the fact that the distribution of steam to the units utilizing it, whether they be heaters, cooking kettles or other mechanical equipment, is best accomplished only by careful calculations whereby the pressure at the inlet to each unit is approximately equalized. This is only possible through the detailed calculation method, which almost every engineer has tried but has eventually abandoned as too impractical for ordinary day-to-day use.

Factors Considered in Maintaining Balance Between Ideal and Practical

Some years ago a large engineering and manufacturing organization undertook the heavy task of figuring *all* steam pipe sizes for heating, industrial and power piping on the fundamental basis of approaching the theoretically correct size just as closely as practical experience warranted. Theory was made secondary to practicality. Absolute accuracy was made secondary to real usability. In arriving at this balance between the ideal and the practical the following factors had to be given careful consideration:

(1) The advantages in operation of the steam system by equalized pipe sizing.

(2) The saving in first cost and, in some cases, heat loss through correct pipe sizing.

(3) The practical operation of the piping system when using correct pipe sizes.

(4) The cost of engineering to determine such correct pipe sizes.

(5) Possible installation complications due to adherence to rigid requirements of correct pipe sizes.

* Manager, Heating, Power and Industrial Piping Division, Grinnell Company.

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0001 to .0005 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot				
			.0001	.0002	.0003	.0004	.0005
	2	3/8	.597	.843	1.02	1.193	1.33
	2	1/2	1.17	1.65	2.00	2.34	2.61
	3	3/4	2.68	3.78	4.58	5.365	5.98
	4	1	5.4	7.6	9.2	10.8	12.00
	5	1 1/4	11.87	16.73	20.3	23.73	26.46
	5	1 1/2	18.45	25.85	31.57	36.92	41.17
12′	7	2	37.38	52.7	64.00	74.8	83.4
	8	2 1/2	61.6	86.8	105.3	123.2	137.3
	10	3	112.79	128.7	193	225.8	251
	12	3 1/2	168.5	237.5	288	337	376
	14	4	238.17	336	407	476.5	530.5
	15	4 1/2	324	456.9	554.5	648.1	722.6
	17	5	440.9	621.6	754.4	881	983
25′	20	6	723.49	1021	1238	1447	1613
	24	7	1071.7	1511	1834	2143	2390
	27	8	1506.4	2124	2578	3013	3359
	30	9	2035.4	2870	3483	4071	4539
	34	10	2749	3876.1	4703.6	5498.1	6130.4
	40	12	4412	6221.2	7549.3	8824.4	9839.2
	47	14	5714	8057.1	9777.1	11428.5	12742.8
	53	16	8238	11615.7	14095.4	16476.2	18371
50′	60	18	11336	15984.8	19397.1	22673.5	25280.9
	67	20	15049	21219.9	25749.9	30099.2	33560.7
	81	24	24460	34489	41852	48922	54548

75′

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0006 to .0010 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot				
			.0006	.0007	.0008	.0009	.0010
	2	3/8	1.455	1.575	1.68	1.79	1.885
12′	2	1/2	2.86	3.09	3.3	3.51	3.7
	3	3/4	6.55	7.08	7.57	8.05	8.48
	4	1	13.17	14.25	15.23	16.2	17.06
	5	1 1/4	28.95	31.33	33.47	35.6	37.5
25′	5	1 1/2	45.05	48.73	52.05	55.4	58.33
	7	2	91.3	98.7	105.5	112.2	118.2
	8	2 1/2	150.3	162.6	173.6	184.7	194.6
	10	3	275.2	297.9	318.1	338.5	356.5
	12	3 1/2	411.2	445	475	502.8	532.5
	14	4	581	629	672	714	752
50′	15	4 1/2	790.7	855.5	913.8	972.2	1024
	17	5	1076	1164	1243	1322	1393
	20	6	1765	1910	2040	2170	2286
	24	7	2615	2829	3022	3215	3387
75′	27	8	3676	3977	4248	4519	4761
	30	9	4967	5373	5740	6106	6432
	34	10	6707.7	7257.5	7752.3	8247.2	8687
100′	40	12	10765.7	11648.2	12442.4	13236.6	13942.5
	47	14	13942.8	15985.6	16114.2	17142.8	18057.1
	53	16	20101	21748.6	23231.5	24714.3	26032.5
125′	60	18	27661.6	29929	31969.6	34910.2	35824.1
	67	20	36721.1	39731	42439.9	45148.9	47556.8
	81	24	59684	64576.9	68979.9	73382.8	77296.6

150′

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0011 to .0015 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot				
			.0011	.0012	.0013	.0014	.0015
12′	2	3/8	1.975	2.06	2.145	2.23	2.31
	2	1/2	3.87	4.05	4.22	4.38	4.53
	3	3/4	8.88	9.28	9.67	10.02	10.37
25′	4	1	17.87	18.68	19.46	20.18	20.89
	5	1 1/4	39.3	41.06	42.78	44.4	45.9
	5	1 1/2	61.5	63.9	66.5	69	71.4
	7	2	123.8	129.3	134.8	139.8	144.7
50′	8	2 1/2	203.8	213	222	230.3	238.3
	10	3	373.5	390.5	406.8	422	436.5
	12	3 1/2	558	583	607.5	630.3	652
	14	4	788	824	858	899	923
	15	4 1/2	1072.6	1121.3	1168.2	1212	1254.1
75′	17	5	1459	1525	1589	1649	1706
	20	6	2394	2503	2608	2706	2800
	24	7	3547	3708	3864	4008	4148
100′	27	8	4987	5212	5431	5634	5830
	30	9	6737	7043	7337	7613	7877
125′	34	10	9099.4	9511.7	9910.4	10281.5	10638.9
	40	12	14604.4	15266.2	15906	16501.6	17075.2
	47	14	18914.2	19771.3	20599.9	21371.3	22114.2
150′	53	16	27268.2	28503.9	29698.4	30810.6	31881.5
	60	18	37524.6	39225.1	40868.9	42399.4	43873.2
	67	20	49814.3	52071.7	54253.9	56285.6	58242.1
	81	24	80965.7	84634.9	88181.7	91484	94663.9

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0016 to .0020 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot				
			.0016	.0017	.0018	.0019	.0020
	2	3/8	2.387	2.46	2.53	2.595	2.665
	2	1/2	4.68	4.825	4.965	5.1	5.23
25′	3	3/4	10.72	11.05	11.37	11.67	12.00
	4	1	21.59	22.25	22.88	23.53	24.13
	5	1 1/4	47.5	48.9	50.3	51.7	53.6
	5	1 1/2	73.8	76.0	77.2	80.4	82.5
50′	7	2	149.5	154.1	158.5	162.9	167.2
	8	2 1/2	246.3	253.8	261	268.3	275.3
	10	3	451.2	465	477.3	491.5	502.1
	12	3 1/2	674	694.5	714.5	734	753.5
	14	4	953	982	1009	1038	1064.5
75′	15	4 1/2	1296.3	1336.1	1374	1412.3	1448.6
	17	5	1764	1818	1869	1921	1970
100′	20	6	2894	2983	3068	3153	3234
	24	7	4287	4419	4544	4671	4791
125′	27	8	6026	6211	6388	6565	6734
	30	9	8142	8392	8630	8870	9098
150′	34	10	10996.2	11334.4	11656	11980	12288.3
	40	12	17648.8	18191.5	18707.7	19228.4	19722.5
	47	14	22857	23559.9	24228.5	24902.7	25542.7
	53	16	32952.5	33965.8	34929.6	35901.7	36824.4
	60	18	45347	46741.4	48067.8	49405.5	50675.2
	67	20	60198.5	62049.6	63810.4	65586.3	67271.9
	81	24	97843.8	100852.5	103714.4	106600.8	109340.5

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Pounds of Steam Carried in Pipe for Drops per Lineal Foot of .0021 to .0025 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot .0021	.0022	.0023	.0024	.0025
	2	3/8	2.73	2.8	2.86	2.92	2.992
	2	1/2	5.36	5.49	5.61	5.725	5.85
25′	3	3/4	12.28	12.58	12.85	13.12	13.42
	4	1	24.74	25.33	25.87	26.45	27.00
	5	1 1/4	54.4	55.7	56.9	57.1	59.35
50′	5	1 1/2	84.6	86.6	88.5	90.4	92.3
	7	2	171.3	175.4	179.3	183.2	187
	8	2 1/2	282	289	295.3	301.7	308
75′	10	3	517.5	529.7	541	552.3	564.1
	12	3 1/2	774	791.5	803	825	843
	14	4	1052	1116	1143	1166	1191
100′	15	4 1/2	1485.1	1520	1553.9	1587.6	1620.3
	17	5	2020	2068	2114	2160	2204
125′	20	6	3315	3393	3469	3544	3617
	24	7	4911	5027	5139	5250	5359
	27	8	6903	7065	7224	7380	7532
150′	30	9	9327	9547.1	9760	9971.7	10177.2
	34	10	12597.9	12894.2	13181.8	13467.6	13745.3
	40	12	20219.3	20695	21156.5	21615.4	22061
	47	14	26186.2	26802.2	27399.9	27994.2	28571.3
	53	16	37752	38640.1	39501.8	40358.6	41190.6
	60	18	51951.7	53173.8	54359.7	55538.7	56683.7
	67	20	68966.4	70588.8	72163	73728.2	75248.2
	81	24	112094.8	114731.7	117290.3	119834.2	122304.8

Pounds of Steam Carried in Pipe for Drops per Lineal Foot of .0026 to .0030 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot .0026	.0027	.0028	.0029	.0030
	2	3/8	3.035	3.035	3.155	3.21	3.26
	2	1/2	5.96	6.08	6.19	6.3	6.41
25′	3	3/4	13.67	13.93	14.19	14.43	14.68
	4	1	27.53	28.05	28.56	29.07	29.57
	5	1 1/4	60.5	61.65	62.8	63.9	65
50′	5	1 1/2	94.1	95.9	97.7	99.4	101.1
	7	2	190.5	194.3	197.8	201.3	204.7
75′	8	2 1/2	314	320	326	331.5	337
	10	3	566.1	586	597	608	617.5
	12	3 1/2	859	875	892	907	923
	14	4	1215	1237.5	1260	1282.5	1304
100′	15	4 1/2	1652.4	1683.9	1714.8	1745.2	1774.9
	17	5	2248	2291	2333	2374	2415
125′	20	6	3689	3759	3828	3896	3963
	24	7	5465	5569	5671	5768	5870
150′	27	8	7682	7828	7971	8112	8251
	30	9	10378.7	10576.6	10770.6	10961.3	11148.1
	34	10	14017.5	14284.7	14546.7	14804.3	15056.7
	40	12	22497.8	22926.7	23347.1	23760.6	24165.6
	47	14	29137	29692.5	30237	30772.4	31297
	53	16	42006.2	42806.9	43592	44363.9	45120.2
	60	18	57806	58908	59988.4	61050.6	62091.3
	67	20	76738.1	78200.9	79635.1	81045.3	82426.9
	81	24	124726.4	127104	129435.2	131727.1	133972.7

Pounds of Steam Carried in Pipe for Drops per Lineal Foot of .0031 to .0035 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot .0031	.0032	.0033	.0034	.0035
	2	3/8	3.315	3.37	3.42	3.475	3.523
	2	1/2	6.51	6.62	6.72	6.83	6.92
25′	3	3/4	14.92	15.17	15.39	15.64	15.85
	4	1	30.06	30.5	31.03	31.47	31.95
	5	1 1/4	66.1	67.1	68.2	69.2	70.1
50′	5	1 1/2	102.9	104.3	106	107.6	109.1
	7	2	208.2	211.3	214.8	218	221
75′	8	2 1/2	343	348	353.7	359	364
	10	3	628	637.5	645	657.8	666.5
100′	12	3 1/2	938	952	969	982.5	995
	14	4	1326	1346	1368	1388	1408
	15	4 1/2	1804.3	1833.2	1861.6	1889.6	1917.2
125′	17	5	2454	2594	2532	2570	2608
150′	20	6	4028	4092	4156	4219	4280
	24	7	5966	6062	6156	6249	6340
	27	8	8387	8521	8653	8784	8912
	30	9	11333	11514.3	11692.8	11868.7	12041.7
	34	10	15306.2	15551.2	15792.3	16029.8	16263.5
	40	12	24566.2	24959.4	25346.3	25727	26102.6
	47	14	31815.9	32325	32826.2	33319.9	33805.6
	53	16	45868.2	46602.2	47324.7	48036.5	48736.8
	60	18	63120.7	64130.8	65125	66104.5	67068.2
	67	20	83793.4	85134.3	86454.1	87754.4	89033.6
	81	24	136193.7	138373.2	140518.4	142631.8	144711

Pounds of Steam Carried in Pipe for Drops per Lineal Foot of .0036 to .0040 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot .0036	.0037	.0038	.0039	.0040
	2	3/8	3.575	3.63	3.67	3.72	3.77
	2	1/2	7.03	7.12	7.21	7.3	7.4
25′	3	3/4	16.08	16.3	16.52	16.73	16.95
	4	1	32.4	32.83	33.27	33.73	34.15
	5	1 1/4	71.2	72.2	73.1	74.1	75.1
50′	5	1 1/2	110.7	112.3	113.8	115.3	116.8
	7	2	224.3	227.4	230.5	233.5	236.5
75′	8	2 1/2	369	374.6	379.6	384.6	389.5
	10	3	677	686	695	704.5	713.7
100′	12	3 1/2	1012	1025	1038	1054	1065
	14	4	1429	1449	1468	1487	1506
	15	4 1/2	1944.4	1971.2	1997.6	2023.8	2049.4
125′	17	5	2645	2681	2717	2753	2788
150′	20	6	4341	4400	4467	4518	4575
	24	7	6430	6518	6606	6693	6778
	27	8	9039	9163	9286	9408	9527
	30	9	12212.7	12381.2	12546.5	12711.4	12872.2
	34	10	16494.4	16722	16945.3	17167.9	17385.1
	40	12	26473.2	26838.5	27196.8	27554.2	27902.8
	47	14	34285.6	34758.7	35222.7	35685.6	36137
	53	16	49428.8	50110.9	50779.8	51447.1	52097.9
	60	18	68020.5	68959.1	69879.7	70798	71693.6
	67	20	90297.8	91543.9	92766	93985	95173.9
	81	24	146765.7	148791.1	150777.3	152758.7	154691.1

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Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0041 to .0045 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot .0041	.0042	.0043	.0044	.0045
25′	2	⅜	3.82	3.863	3.91	3.955	4.0
	2	½	7.49	7.58	7.67	7.76	7.85
	3	¾	17.17	17.37	17.58	17.78	17.98
50′	4	1	34.57	35.0	35.4	35.8	36.23
	5	1¼	76.0	76.9	77.8	78.7	79.6
75′	5	1½	118.1	119.6	120.9	122.3	123.8
	7	2	239.3	242.3	245	248	250.8
100′	8	2½	394	399	403.8	408.3	413
	10	3	722	731	739	748	756
125′	12	3½	1079	1093	1105	1117.5	1130
	14	4	1525	1543	1565	1580	1596
150′	15	4½	2075	2100	2124.9	2149.5	2173.9
	17	5	2823	2857	2891	2924	2957
	20	6	4633	4688	4744	4799	4853
	24	7	6862	6945	7027	7109	7189
	27	8	9646	9762	9878	9992	10106
	30	9	13033	13189.7	13346.4	13501.1	13653.8
	34	10	17602.3	17813.9	18025.6	18234.5	18440.7
	40	12	28251.3	28591.1	28930.8	29266.1	29597
	47	14	36588.4	37028.4	37468.4	37902.7	38331.3
	53	16	52748.7	53383.1	54017.4	54643.5	55261.4
	60	18	72589.2	73462.1	74335	75196.6	76046.9
	67	20	96362.8	97521.6	98680.5	99824.2	100953
	81	24	156623.5	158507	160390.5	162249.5	164084.1

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0046 to .0050 Lb.

Velocity Ft. Per Sec	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot .0046	.0047	.0048	.0049	.0050
25′	2	⅜	4.04	4.09	4.13	4.175	4.215
	2	½	7.93	8.02	8.1	8.19	8.27
	3	¾	18.18	18.37	18.57	18.77	18.95
50′	4	1	36.63	37.0	37.4	37.8	38.17
	5	1¼	80.5	81.3	82.2	83.1	83.9
75′	5	1½	125.2	126.5	127.8	129.2	130.5
	7	2	253.5	256.3	259	261.7	264.3
100′	8	2½	417.8	422	426.7	431	435.3
	10	3	765	772.5	782	789.5	791
125′	12	3½	1143	1155	1167.5	1179	1192
	14	4	1615	1632	1650	1667	1685
150′	15	4½	2197.8	2221.5	2245.2	2268.5	2291.5
	17	5	2990	3022	3054	3086	3117
	20	6	4907	4960	5012	5064	5116
	24	7	7268	7347	7425	7502	7578
	27	8	10217	10327	10437	10545	10652
	30	9	13804.4	13953	14101.6	14248.1	14392.7
	34	10	18644.2	18844.8	19045.5	19243.5	19438.8
	40	12	29923.5	30245.6	30567.7	30885.4	31198.7
	47	14	38754.1	39171.3	39588.4	39999.9	40405.6
	53	16	55871	56472.4	57073.7	57666.9	58251.8
	60	18	76885.8	77713.4	78541	79357.2	80162.1
	67	20	102066.6	103165.3	104263.9	105347.5	106416
	81	24	165894.2	167679.9	169465.5	171226.7	172963.4

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0051 to .0055 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot .0051	.0052	.0053	.0054	.0055
25′	2	⅜	4.26	4.3	4.34	4.375	4.42
	2	½	8.36	8.44	8.52	8.6	8.67
	3	¾	19.13	19.32	19.5	19.68	19.89
50′	4	1	38.55	38.88	39.3	39.65	40.0
	5	1¼	84.8	85.6	86.4	87.2	87.9
75′	5	1½	131.8	133.1	134.4	135.7	136.8
	7	2	267	269.5	272.2	274.7	277
100′	8	2½	439.6	444	448.3	452.5	456.6
	10	3	805.5	813	821	829.5	836
125′	12	3½	1204	1214	1226	1238	1249
	14	4	1690	1716	1734	1750	1765
150′	15	4½	2314	2336	2359	2381	2403
	17	5	3148	3179	3209	3240	3269
	20	6	5166	5217	5267	5316	5365
	24	7	7653	7728	7802	7875	7948
	27	8	10758	10863	10967	11070	11172
	30	9	14535.1	14677.6	14818.1	14956.5	15094.9
	34	10	19631.1	19823.5	20013.2	20200.1	20387.1
	40	12	31507.5	31816.4	32120.8	32420.9	32720.9
	47	14	40805.6	41205.6	41599.9	41988.4	42377
	53	16	58828.5	59405.1	59973.6	60533.8	61094
	60	18	80955.7	81749.3	82531.5	83302.4	84073.3
	67	20	107469.5	108522.9	109561.4	110584.7	111608.1
	81	24	174675.7	176388	178075.8	179739.1	181402.5

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0056 to .0060 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot .0056	.0057	.0058	.0059	.0060
25′	2	⅜	4.46	4.5	4.54	4.58	4.62
	2	½	8.75	8.83	8.9	8.99	9.06
	3	¾	20.07	20.23	20.42	20.6	20.75
50′	4	1	40.4	40.76	41.1	41.46	41.83
	5	1¼	88.8	89.6	90.4	91.2	91.9
75′	5	1½	138.1	139.3	140.5	141.8	143
	7	2	279.7	282.3	284.7	287.2	289.6
100′	8	2½	461	465	469	473	477
	10	3	846	852	858.5	866	874
125′	12	3½	1262	1272	1283	1294	1306
	14	4	1783	1799	1813	1830	1845
150′	15	4½	2425	2446	2467	2489	2510
	17	5	3299	3328	3357	3386	3415
	20	6	5414	5462	5509	5557	5604
	24	7	8020	8091	8161	8232	8302
	27	8	11273	11372	11472	11571	11669
	30	9	15231.3	15365.6	15499.9	15634.3	15766.6
	34	10	20571.2	20752.7	20934.1	21115.6	21294.2
	40	12	33016.5	33307.7	33598.9	33890.1	34176.9
	47	14	42759.8	43137	43514.1	43891.3	44262.7
	53	16	61645.9	62189.6	62733.3	63277.1	63812.5
	60	18	84832.9	85581.1	86329.3	87077.5	87814.4
	67	20	112616.4	113609.7	114603	115596.3	116574.5
	81	24	183041.4	184655.8	186270.2	187884.6	189474.6

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Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0061 to .0065 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot				
			.0061	.0062	.0063	.0064	.0065
25′	2	⅜	4.66	4.69	4.73	4.77	4.81
	2	½	9.14	9.21	9.28	9.36	9.43
	3	¾	20.92	21.2	21.25	21.45	21.6
50′	4	1	42.17	42.5	42.85	43.2	43.5
	5	1¼	92.7	93.4	94.1	94.9	95.7
75′	5	1½	144.1	145.3	146.4	147.6	148.8
100′	7	2	292	294.3	296.7	299	301.3
	8	2½	481	494.6	488.5	492.6	496.5
125′	10	3	881	888	894.5	902.5	909
	12	3½	1315	1326	1338	1349	1358
150′	14	4	1857.5	1875	1890	1905	1920
	15	4½	2531	2551	2572	2592	2612
	17	5	3443	3471	3500	3527	3554
	20	6	5651	5697	5742	5788	5833
	24	7	8370	8439	8506	8574	8640
	27	8	11766	11862	11957	12052	12145
	30	9	15896.9	16027.1	16155.4	16283.6	16409.8
	34	10	21470.2	21646.1	21819.3	21992.5	22163
	40	12	34459.3	34741.7	35019.6	35297.6	35571.2
	47	14	44628.4	44994.1	45354.1	45714.1	46068.4
	53	16	64339.8	64867	65386	65905	66415.8
	60	18	88540	89265.5	89979.7	90694	91396.8
	67	20	117537.7	118500.8	119449	120397.1	121330.2
	81	24	191040.1	192605.6	194146.6	195687.7	197204.3

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0066 to .0070 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot				
			.0066	.0067	.0068	.0069	.0070
	2	⅜	4.84	4.88	4.915	4.95	4.985
	2	½	9.5	9.58	9.65	9.72	9.78
50′	3	¾	21.8	21.95	22.1	22.25	22.4
	4	1	43.87	44.2	44.5	44.8	45.17
	5	1¼	96.4	97.1	97.8	98.6	99.3
75′	5	1½	149.9	151	152.2	153.2	154.4
100′	7	2	303.7	306	308.3	310.6	312.7
	8	2½	500.5	504	508	511.5	515
125′	10	3	916.5	923.5	931	936	944
150′	12	3½	1370	1380	1390	1398	1410
	14	4	1935	1950	1965	1980	1994
	15	4½	2632	2652	2672	2691	2711
	17	5	3581	3609	3636	3662	3689
	20	6	5878	5922	5966	6009	6053
	24	7	8707	8772	8838	8902	8966
	27	8	12239	12331	12423	12513	12603
	30	9	16536	16660.2	16784	16906.4	17028.6
	34	10	22333.4	22501.1	22668.8	22833.7	22998.7
	40	12	35844.7	36113.9	36383	36647.7	36912.5
	47	14	46422	46771.3	47119.8	47462.7	47805.5
	53	16	66926.5	67429.1	67931.6	68425.9	68920.2
	60	18	92099.7	92791.2	93482.8	94163	94843.2
	67	20	122263.3	123181.3	124099.3	125002.3	125905.3
	81	24	198720.8	200213	201705.1	203172.7	204640.4

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0071 to .0075 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot				
			.0071	.0072	.0073	.0074	.0075
	2	⅜	5.025	5.06	5.09	5.13	5.165
	2	½	9.86	9.93	10.0	10.07	10.13
	3	¾	22.6	22.73	22.9	23.05	23.2
50′	4	1	45.5	45.8	46.1	46.45	46.76
75′	5	1¼	100	100.7	101.4	102.1	102.8
	5	1½	155.5	156.6	157.7	158.8	159.8
100′	7	2	315	317.3	319.5	321.5	323.8
125′	8	2½	519	521.5	526	530	533.4
	10	3	950	958	964	970	977
150′	12	3½	1420	1430	1440	1450	1460
	14	4	2009	2021	2035	2050	2062
	15	4½	2730	2749	2768	2787	2806
	17	5	3715	3741	3767	3793	3818
	20	6	6096	6139	6182	6224	6265
	24	7	9030	9094	9157	9219	9281
	27	8	12694	12783	12872	12959	13046
	30	9	17150.7	17270.8	17390.9	17508.9	17627
	34	10	23163.6	23325.8	23488	23647.5	23806.9
	40	12	37177.2	37437.5	37697.9	37953.8	38209.7
	47	14	48148.4	48485.5	48822.7	49154.1	49485.5
	53	16	69414.5	69900.5	70386.6	70864.4	71342.2
	60	18	95523.4	96192.3	96861.1	97518.7	98176.2
	67	20	126808.3	127696.2	128584.1	129457	130329.9
	81	24	206108	207551.2	208994.4	210413.2	211831.9

Pounds of Steam Carried in Pipe *for* Drops per Lineal Foot of .0076 to .0080 Lb.

Velocity Ft. Per Sec.	Equiv. Lengths in Feet of Each Elbow	Pipe Size	Pounds Drop Per Lineal Foot				
			.0076	.0077	.0078	.0079	.0080
	2	⅜	5.20	5.23	5.27	5.3	5.33
	2	½	10.18	10.26	10.33	10.39	10.46
50′	3	¾	23.35	23.52	23.66	23.8	23.97
	4	1	47.04	47.4	47.67	48.0	48.3
75′	5	1¼	103.4	104.1	104.8	105.5	106.2
	5	1½	160.8	161.9	163	164.2	165.1
100′	7	2	325.8	328	330	332.3	334.5
125′	8	2½	536.5	540.5	544	548	551
	10	3	983	990	996	1004	1009
150′	12	3½	1468	1478	1488	1497	1507
	14	4	2075	2090	2103	2117.5	2130
	15	4½	2824	2843	2861	2880	2898
	17	5	3843	3869	3894	3919	3943
	20	6	6307	6349	6389	6430	6471
	24	7	9342	9404	9464	9526	9586
	28	8	13132	13220	13304	13390	13474
	30	9	17743	17861.1	17975.1	18091.1	18205.1
	34	10	23963.6	24123	24277	24433.7	24587.6
	40	12	38461.2	38717.1	38964.2	39215.7	39462.7
	47	14	49811.3	50142.7	50462.7	50788.4	51108.4
	53	16	71811.8	72289.6	72750.9	73220.5	73681.8
	60	18	98822 4	99479.9	100114.8	100761	101395.8
	67	20	131187.7	132060.6	132903.4	133761.2	134604
	81	24	213226.2	214644.9	216014.7	217409	218778.8

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New Pipe Tables First Step Toward Practical Solution

It was found that as a first step toward a more practical solution of these factors, new tables of steam pipe sizes were required. Tables were developed, therefore, with sufficient detailed graduations as to require no interpolation or further development by the engineer. These were found to add a considerable degree of accuracy to the calculations and also to save considerable engineering time.

Because these tables have been found helpful to a point of permitting calculations to a much finer degree than might otherwise be practical, and believing that they may assist toward greater accuracy and more economy in steam piping systems of any kind, a number are reproduced herewith and the remainder will be presented in succeeding articles.

With them are given detailed explanations of how to apply them in a practical way to several typical conditions. If the limits of accuracy toward which these solutions tend seem extreme, it can only be said in defense that by much actual experience these methods have been found practical.

It is hoped, however, that whether the engineer agrees fully with the methods outlined or not, he may find uses for these tables which have proved so valuable to others.

The Tables Explained

The reference tables appearing in this and in succeeding articles are figured in accordance with the following generally accepted formula for friction through pipes with steam:

$$W = 5220 \sqrt{\frac{D\,(P_1 - P_2)\,d^5}{L\left(1 + \frac{3.6}{d}\right)}}$$

In which:

W = Pounds of steam per hour.

D = Density of steam (Atmosp. = .03732 lb.; $\sqrt{.03732} = .1932$).

P_1 = Pressure at starting point.

P_2 = Pressure at end.

d = Diameter of pipe.

L = Length of pipe (1′ 0″).

In the formula the figure for density of steam at ½ lb. gage pressure has been used. This was chosen as a basis for the tables because their greatest and most complicated use is in conjunction with low pressure steam heating work where the operation is usually from 2 lb. downward.

The figures in the main body of the tables represent the *pounds of weight of steam carried per hour*. This expression of measurement was used because, while possibly not as convenient for heating as if expressed in square feet of radiation, it is a more accurate basis for calculation. It also lends itself much better to calculations for other purposes than heating such as industrial piping, power piping, etc. (Later will be shown a table of conversion factors for any condition of steam pressure or temperature.) Furthermore, heating work now involves so many devices other than cast iron radiation, such as unit heaters, concealed copper radiation, etc., that all load quantities must necessarily be reduced to some common denominator. The one chosen, therefore, seems to have a wider application than any other.

Across the top of the tables in large figures is shown the *drop* or loss in gage pressure per foot of length of the pipe, reduced to ten-thousandths. Pressure drops are included from 0.0001 lb. per foot to 1.0 lb. per foot for all regular standard pipe sizes ⅜ in. to 24 in. O. D. It will be obvious that in the larger sizes of pipe where several weights are available, and that where extra heavy or double extra heavy pipe is used, there will be some error in the calculations for total drop. However, in view of the fact that we are chiefly interested in relative drop as between various piping connections or equalizing resistances rather than accuracy as to the total drop in pressure, it has been found practical to neglect this factor.

In the vertical column next to the pipe sizes are given the *equivalent lengths in feet of the elbow*. This, for convenience, is shown on each page of the tables. This means that for each elbow in the piping, a footage of the amount shown in this column is added to the actual feet of straight pipe.

Example: A 2 in. connection has 20 ft. of straight pipe and two elbows. 20 ft. plus $(2 \times 7) = 34$ ft. total equivalent length.

For practical purposes the following are also included as the equivalent of the number of elbows as listed:

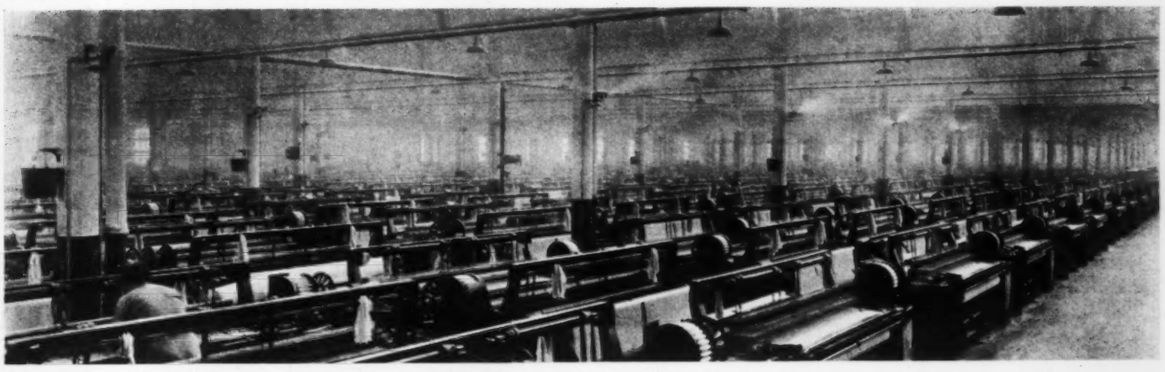
1. Globe valve ..... 3 elbows
2. Connection out of side of tee, cross or Y fitting ..... 2 elbows
3. Outlet from (not inlet into) radiator, boiler, tank ..... 2 elbows
4. Angle ells, long radius ells, reducing ells... 1 elbow

No allowance is made for slight interruptions to straight-through flow such as couplings, end outlets of practically straight tees, crosses or full-opening gate valves.

It is realized that the foregoing is at some variance with most authorities, who give more accurate ratings to these various factors. Again, however, this is intended as a practical handling of the subject and if it varies somewhat from the theoretical, it is because certain simplifications have been found necessary to make this a workable method for everyday use. It should be borne in mind that these simplifications have been long tried and found to give practical results.

In the vertical column at the extreme left of the tables is given the *velocity of steam in feet per second*. Practically the only use for these values is in the lower velocities for heating work, where it occasionally becomes necessary to bring back the condensate against the flow of steam and therefore the "critical" or "terminal" velocity should be known. Just how this is taken care of in connection with this method of sizing will be covered later with the actual examples. In the tables, only velocities of from 12 ft. per second up to 150 ft. per second have been shown, but, of course, other velocities may be calculated readily if ever needed.

With this general explanation of terms and conditions we will proceed in the next issue of HEATING, PIPING AND AIR CONDITIONING to actual examples of how the tables are used.



ATOMIZER TYPE OF HUMIDIFIER IN A COTTON MILL WEAVE ROOM

Operating a Woolen Mill Humidifying System Correctly

By James W. Cox, Jr.*

GOOD profits are being made by some woolen mills. These mills, however, do not represent one hundred per cent of those in operation. Profit making nowadays means that every department must be run in the very best possible manner. As humidification is one of the effective tools used by a woolen mills in making profits, this article is written to explain what proper humidification did in one department of one mill, the troubles encountered in operating the humidifying apparatus, how they were overcome and how the profitable results finally were obtained.

This was duplicated shortly afterwards in every department and similar remarkable results have been obtained in other types of mills making products wholly or partially of wool, i. e., worsted spinning or weaving mills, pressed or woven felt mills, as well as knitting mills of various kinds making and using worsted, woolen or merino yarns. The troubles described in this article are those which occur in practically all mills of the above mentioned types and can be controlled by the same general methods.

The use of humidification systems is not common practice in mills making products of wool or wool mixtures. It is not a generally accepted fact in this branch of the industry, that humidification is necessary. This is quite opposite to the opinions held by the cotton branch of the trade, where it has been recognized for a long time that a cotton mill cannot make consistently good products at a profit without the installation of some kind of humidification system.

Why This Mill Was Operated at a Loss

A medium-sized New England woolen mill was operating at a loss. The treasurer and agent picked out the best possible stock for the higher grade yarns and very good stock for the medium grade yarns but the plant never was able to make good yarn. Trouble centered in the roping[1] from the card room; it would vary radically month to month, week to week, day to day and even hour to hour when presumably it should be running the same. This naturally resulted in uneven yarn and cloth later. Production would vary and it was a frequent occurrence to have orders cancelled because of late deliveries.

There were many things changed and improved from men to machinery. These cannot be discussed here. Space permits only the discussion of troubles in the card room humidification.

The mill had no humidifying system. It was decided to install one, first in the carding department (shortly followed by spinning, spooling, dressing and weaving and a year later in the picker house[2] and dry finishing) because experience had proven that such a step would avoid electricity on cold days; assure generally better running conditions; improve the quality of the roping; make the roping more even as to weight; increase the production; decrease the percentage of waste; decrease the net cost per pound to card and result in more contented help.

Humidifying equipment was installed and started in operation. Immediately there was trouble from the stock not running well, more uneven roping, extreme variation in roping weights, occasional bad wetting down on machines and stock, damaged belts, continual complaint from the help, etc., ad infinitum.

The writer was asked immediately to explain this, to investigate and correct the matter at once. The help was prejudiced. The foreman was against humidifiers in general as is the case with many of them until they use them once. The ceilings were low as is the case in many an old mill. Water would deposit on machines and the floor. There were other troubles which always occur

* Cox, Fuller & Mauersberger, consulting textile specialists.

[1] Roping is the rope-like material of wool fibers before it is twisted into yarn.

[2] A picker is a machine which mixes various qualities and lengths of wool fiber before going to the carding machinery.

A New England woolen mill, operating at a loss, installed a humidifying system. Trouble was experienced immediately after its installation, due to several factors. How the humidification equipment was made to operate efficiently, and how its installation saved the mill many dollars every year, is told here

when anything different from ordinary practice is started in a mill.

What the Investigation Showed

From careful checking of the temperature and humidity conditions in the room, the equipment, machinery, stock and the help, it was ascertained that not one of the main causes of the trouble was the fault of the humidifier manufacturer, the machinery, the stock or the help; it was entirely the fault of the management in not operating the equipment properly and in not controlling other factors which are vital to good operation of any card room.

The investigation showed that:

1. The water pressure on the humidification system varied extremely because the pump furnishing water to the system was not large enough to take care of peak loads in the wet finishing department which it also served. Fluctuations were reflected directly in the humidifying water pressure.
2. The air pressure varied extremely, solely because of poor operation of the compressor.
3. The heads were not cleaned properly or often enough.
4. The controls were not cleaned properly or often enough.
5. The temperature of the room was allowed to vary excessively.
6. The temperature was allowed to drop much too low during nights and over week ends.
7. There were excessive drafts of air of varying temperature and humidity through uncontrolled opening or regulation of windows, doors, a stair opening, an ordinary elevator opening, two roping elevators and the blower system from the picker house.
8. The moisture content of the stock as put in the feeds varied from 16 to 34 per cent between batches and at times almost as badly in a single batch.
9. The average moisture content of the batches off the picker was approximately 30 per cent, in the card room bins about 25 per cent, in the feeds[3] between 15 and 20 per cent and dropped to an average of about 6 in the roping, with extreme variations throughout.
10. The foreman was carrying too high a humidity.
11. The foreman was keeping his room much too cool for best work.
12. The foreman was doing everything he could to make the humidifiers operate poorly in the hope that they would be taken out.

How the Troubles Were Overcome

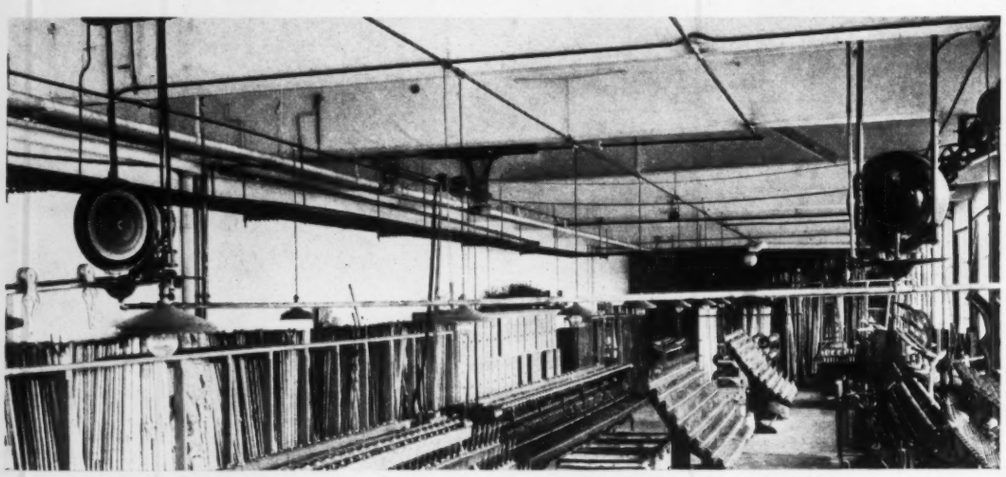
Most of the troubles were eliminated within a few days by making the changes described here and all were eliminated inside of a month. Since then there has been no trouble which could not be ascertained and corrected quickly by the men at the mill without outside assistance.

The whole system was put in charge of the master mechanic. The changes made are given below, each heading number referring to the troubles listed above under the corresponding number.

1. A separate tank of sufficient size to take care of all peak loads was installed in the tower of the mill. Even pressure of water thus was assured.
2. Responsibility for the operation of the compressor was placed upon the engineer.
3. The heads were cleaned properly, regularly and often by a special man designated for the purpose, who was responsible to the master mechanic.
4. The controls were cleaned properly, regularly and often by the same man.

[3] Hopper attachments which automatically feed fiber to the carding machine.

HORIZONTAL SHAFT FAN TYPE HUMIDIFIERS IN THE WINDING AND WARPING DEPARTMENT OF A HOSE MILL



5. The temperature of the room was not allowed to vary excessively, through the installation of the proper control valves in the heating system.

6. The temperature of the room was never allowed to drop under 70 F, day or night.

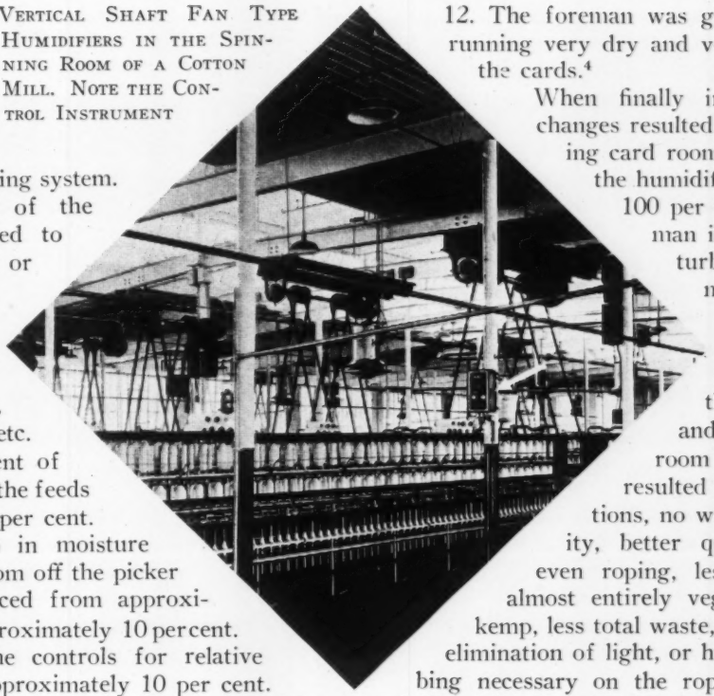
7. Excessive drafts of air were stopped by controlling the opening of windows, doors, elevator shafts, etc.

8. The moisture content of the stock as delivered to the feeds was controlled within 5 per cent.

9. The average drop in moisture content in the batches from off the picker to the roping was reduced from approximately 25 per cent to approximately 10 per cent.

10. The setting of the controls for relative humidity was lowered approximately 10 per cent.

11. The average temperature maintained in the room was 78 F.



Vertical Shaft Fan Type Humidifiers in the Spinning Room of a Cotton Mill. Note the Control Instrument

12. The foreman was given an object lesson in running very dry and very wet stock on one of the cards.[4]

When finally in operation, the above changes resulted in a much better operating card room and if, for any reason, the humidifiers did not work almost 100 per cent perfectly, the foreman immediately raised a disturbance until the master mechanic had things again running properly.

More specifically the proper installation and operation of the card room humidifying system has resulted in better general conditions, no wetting down, no electricity, better quality of roping, more even roping, less droppings, droppings almost entirely vegetable matter, dirt and kemp, less total waste, better drawing of stock, elimination of light, or heavy, side ends, less rubbing necessary on the roping, less adjustment of weigh pans on feeds, increased production, decreased net cost per pound to card and more contented help.

No longer do the superintendent or foreman oppose humidified rooms. They fight when the slightest variations from proper conditions occur.

[4] If desired, questions regarding the above twelve operations may be sent to Heating, Piping and Air Conditioning.

Vacuum System Heats Royal Insurance Building

By William S. Gaylor

THE Royal Insurance building, New York, N. Y., occupies a plot approximately 177 ft. by 120 ft. It is a brick and steel structure, twenty-two stories in height, two stories below grade, nineteen stories and pent house above grade, and with a cubiture of 5,411,000 cubic feet.

The building, together with the complete mechanical equipment, was designed by Starrett and Van Vleck. The construction work was in the hands of Marc Eidlitz & Sons, General Contractors, with Gillis & Geoghegan as sub-contractors for the heating and ventilating.

The direct heating system is an up-feed vacuum return system, taking steam from the mains of the New York Steam Corporation through a six-inch service line. This service line drops to the service room in the second basement level. To insure constant service an auxiliary steam line, three inches in diameter, enters the building from the service main and connects to the six-inch main in the service room. Two steam meters are used, one for the direct radiation and the ventilating system, the other for utility steam for hot water and restaurant use.

In addition to a load of 41,500 sq. ft. of direct radiation in the Royal Building, steam is supplied to a group of small buildings on the opposite side of Ann Street containing 8,300 sq. ft. of radiation. Hot water and restaurant service are furnished to both buildings. The total steam required for the entire plant approximates 23,000,000 lb. per year, of which 17 per cent is required for utility purposes.

All condensates are returned to a receiving tank connected to a group of three vacuum return pumps of capacity of 40,000 sq. ft. each. The condensate is discharged to the sewer after passing through a preheater and a spray tank.

The low pressure distributing mains are all run on the ceiling of the second basement. Vertical risers and radiator branches are concealed throughout, radiators wall hung and exposed except in executive offices. All radiators, except in stair halls, are under thermostatic control.

In the operation of the heating system it has been found that circulation is completed within fifteen minutes from the time the main valve is opened. This necessitated the operation of only one vacuum pump. The system can also be operated entirely by gravity.

The ventilating system can be divided into three general groups:

(a) Supply and exhaust to areas below third floor.
(b) Exhaust only from all areas from third to twelfth floors, inclusive.
(c) Exhaust from all toilet and locker rooms, and exhaust from intermediate elevator machine room on twelfth floor.

The supply system consists of five units, those for the basement, first and second floors, four in number, being equipped with air washers, heating stacks, and cell type air filters. The fifth unit supplying the sub-basement is equipped with heating stacks only, and is so arranged that air may be drawn either from the fresh air

intake or from the basement exhaust system. Fresh air is taken from Fulton Street, through sidewalk gratings, into the basement vault space where the heavier dirt settles, then down to the sub-basement level. Shut-off dampers with pneumatic control are provided in the intakes to each supply unit.

Washer Chambers of Terra Cotta

The air washer chambers were constructed of terra cotta, cemented, instead of the usual sheet metal housings. Each of the four chambers contains the tempering stacks, a single bank of spray heads, together with copper eliminators and flooding nozzles. The water pans are formed by the floors of the chambers, and drain into two suction tanks formed between the spread footings. Two centrifugal washer pumps were installed, one for each two washers.

The supply units have a total capacity of 86,000 c.f.m. with a total of 5,232 square feet of heating stack surface. The corresponding exhaust fans, four in number, handling a total of 76,000 c.f.m., discharge to Ann Street at the first floor ceiling level. All fans are driven by direct connected, direct current motors, with variable speed control.

Air distribution through sheet metal ducts is at the ceiling; the exhaust, except in the basement, which contains a number of small shops, is also from the ceiling. The ducts are run in the furred ceiling of corridors around the utility group in the center of the building.

The exhaust system for the areas from the third to twelfth floors, inclusive, was figured at 16,800 c.f.m. per floor. Part of this, 4,800 c.f.m., is exhausted through the toilet and locker rooms, leaving a balance of 12,000 c.f.m. per floor to be handled by the general exhaust fan.

The lateral duct systems were designed on this basis, with the exhaust fan sized to handle 30 per cent of the entire exhaust from the ten floors. These lateral ducts are run in the corridor ceilings and connect to a common exhaust shaft with fan located in pent house.

The toilet and locker room exhaust system, with a capacity of 54,000 c.f.m. divided between two fans, located in pent house, provides a heavy exhaust from the toilets and lockers throughout the building. The exhaust from the intermediate elevator machine room on the twelfth floor is handled by a separate fan located in that room and provides a means of preventing over-heating of the motors.

To provide for the possible need of additional ventilation in areas above the second floor as the occupancy changes, each steam and return riser was sized to carry the additional load of three unit ventilators of 900 c.f.m. capacity each. Branches at each floor were arranged to handle this condition. At the time the building was occupied thirty unit ventilators were installed, arranged to take fresh air from above the window sill.

The operation of the mechanical plant is in the hands of exceedingly high grade men who are thoroughly acquainted with the various systems and are continually striving for better results.

The Royal Insurance Building, New York City, Starrett & Van Vleck, Architects

Sampling Pulverized Coal

Velocity in a stream of air in a pipe varies over its cross-section, and the density of the coal and air mixture will correspondingly vary over the cross-section. Friction of the wall retards the flow to some extent. The larger particles tend to hug the walls. It may be seen from these considerations how difficult a matter it is to obtain a representative sample as to fineness from a moving air stream.

At the Detroit Edison Co.'s Trenton Channel plant, which is an indirect storage system, several different methods and locations for sampling have been tried. According to W. A. Carter, technical engineer of power plants, and V. S. Barretta, boiler room engineer at Trenton Channel:

It has been found most satisfactory to take samples by means of a "thief" sampler of a double-barreled construction arranged so that the open slot can be closed before taking from the coal stream.

This is used in the coal-discharge pipe from the cyclone separators. As long as the cylinders remained clean, the results were consistent, varying only 3 per cent in fineness as against 15 to 20 per cent obtained when using other methods. A previous method was to insert a quart jar into the coal-discharge pipe from the cyclone at different points, but this proved unsatisfactory because the duct had to be left open to the atmosphere, which created a disturbing velocity condition different from that existing when the duct was closed.

Fairly satisfactory samples were obtained by taking portions periodically from the bunker, using a cup on the end of a pole, but this could not show the results obtained with each mill.

Sampling from the coal-and-air stream in the feeder pipe above the burners has also been tried at Trenton Channel, using a small pipe with the nozzle pointed in the direction of the coal stream. Results were unsatisfactory with this method due to large variations depending upon the position of the nozzle in the coal stream.

Engineering Analysis

Saves Over $300.00 Per Day

in Operating Hotel Plant

By Samuel R. Lewis*

DURING 1928 we investigated and reported on the mechanical equipment of a large hotel. During 1929, following this report and in accordance with it, the owner invested about $125,000.00 in new coal burning and handling apparatus, and in uniflow engines and generators.

It is interesting to make some record of the matter in the light of the operating costs developed since the installation was completed.

The heating load, exclusive of service hot water, based on flow meters for about 75 per cent of the total, and on estimates for the remainder, is as follows:

Equivalent direct radiation: 120,000 sq. ft.

Lb. of steam per year: 63,180,000.

Lb. of steam per equivalent sq. ft. of radiation: 526½.

The water heating load is based on meters for about 85 per cent of the total, the remainder being estimated. There is a large laundry, and practically all rooms have baths.

The water heating demand is expressed in pounds of steam for convenience, and is, per year, 48,000,000.

The total demand for heat, involving the combustion of fuel is, therefore, 111,180,000 lb.

This is 926 lb. of steam per year per sq. ft. of heating radiation, total heating, laundry, cooking and hot water demand, compared with 800 pounds for the same purpose given for hotels in the *A. S. H. V. E. Guide*.

Based on standard experience tables from central station practice this load may fairly be divided into monthly increments as follows:

Monthly demand, in lb. of steam, including 2,000,000 lb. per month of high pressure steam used directly for cooking and laundry and for steam driven power—

January	18,500,000
February	15,400,000
March	13,500,000
April	9,695,000
May	5,280,000
June	4,000,000
July	4,000,000
August	4,000,000
September	4,000,000
October	7,780,000
November	12,240,000
December	12,785,000
Total per year	111,180,000

The physical plant as originally installed, apparently without much consideration by the owner of the engineer's recommendations, consisted of three 415 hp., normal rating, cross drum, water-tube boilers, set rather low, and designed to burn fuel oil (and nothing else), despite a price of around 9 cents per gallon for such fuel in that zone. (Nine cents is higher than the price in many parts of the country, and this high rate of course affects the change described in the latter part of this article.)

*Consultng engineer, Chicago.

ONE OF THE THREE AUTOMATIC STOKERS. THE LARGE FORCED DRAFT FANS PROJECT PARTLY ABOVE THE PIT

No provision was made for generating electricity.

The boilers were built for 160 pounds pressure, and had a chimney over 500 feet high. No provision was made for entry or for storage of any fuel except oil.

Estimated Amount of Oil Used

With ordinary fuel oil for direct steam heating we may assume a demand of 4 gallons per season per equivalent square foot of radiation, a recognized fair average.

If we reduce the 111,180,000 lb. of steam to equivalent sq. ft. by dividing it by 526, the demand for heating only is, say, 211,000 square feet, which, at 4 gallons of oil per foot, is 844,000 gallons per season. At 9 cents per gallon there would be a yearly fuel cost of $75,960.00.

We are compelled to estimate the oil cost in this way because oil was never burned for a full season for the full load; the cost proving so high that after natural gas burners were hurriedly shoved into one of the furnaces through holes cut below the oil burners and tried for a time, the steam generating plant was abandoned, and some old hand-fired coal-burning boilers were pressed into service. These happened to be available in an adjacent building.

Natural Gas Consumption

The natural gas was obtained at 45 cents per thousand cu. ft.

Gas burned during July, August and September, 1928, indicated by meter that 2.35 cu. ft. of gas were required per lb. of steam evaporated, an efficiency from gas meter through furnace and boiler to steam meter of about 43 per cent.

This is not surprising when the makeshift arrangement and leaky furnaces are considered. The furnace walls showed no visual evidence of ever having encountered a hot fire from the gas, though the gas burners were about nine feet below the boiler tubes.

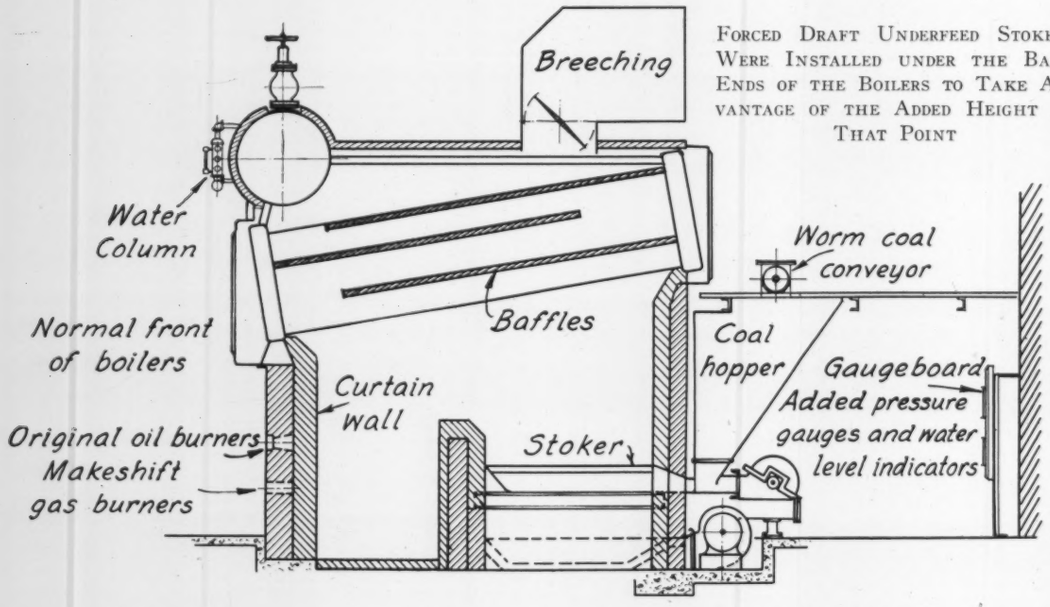
Applying this factor of 2.35 cu. ft. of gas per lb. of steam, they would have required per season, 261,000,000 cu. ft. of gas, costing (at 45 cents per thousand cu. ft.) $117,450.00.

Assuming conservatively that the efficiency of the gas burners could have been increased to 60 per cent, and that the gas rate could have been forced down to 40 cents per thousand cubic feet, the gas cost per year would have been $74,000.00, or about that which was indicated for oil.

Saving with Bituminous Screenings

Bituminous screenings of 13,000 heat units per lb. were available, costing $4.50 per ton.

A stoker manufacturer guaranteed an over-all efficiency for furnace and boiler of 76 per cent at 125 per cent of boiler rating.



FORCED DRAFT UNDERFEED STOKERS WERE INSTALLED UNDER THE BACK ENDS OF THE BOILERS TO TAKE ADVANTAGE OF THE ADDED HEIGHT AT THAT POINT

On this basis the yearly cost for 111,180,000 lb. of steam was computed as $25,654.00, a distinct saving over the experienced cost for oil or gas at the prices at which they were obtainable and under the conditions in which they were installed and operated.

Converting to Coal

Contracts were let for building a hopper-bottom coal bunker, with an apron conveyor under it feeding a bucket elevator, which in turn feeds a worm-conveyor which carries the coal about 75 feet and discharges it continuously or intermittently as desired into the enlarged stoker-hoppers.

In case of breakdown in the coal conveying system, there is an emergency manually-operated hopper door and coal may be wheeled in carts via a platform elevator, for final discharge into the hoppers.

Three forced draft underfeed stokers of the automatic electric-driven unit type were installed under the back ends of the boilers, so as to take advantage of the added height at that point. An automatic combustion control system was installed. It was necessary to provide remote-reading water level indicators, since the original water columns could not be seen from the new firing aisle.

This added equipment for burning coal required an investment of $42,000.00. Allowing 6 per cent interest ($2,520.00), and 5 per cent depreciation ($2,100.00),

and allowing one extra fireman per shift, we reach a cost of $10,095.00, or allowing for slippage, say, $12,000.00 per year beyond the actual fuel cost.

Thus by burning coal, with allowance for the extra capital and labor charges over oil or gas, we require around $38,000.00 per year compared with around $75,000.00 per year for this *particular* plant with oil or gas.

Results

Six months' operation of the rebuilt plant has proved the truth of the figures quoted above for operating costs with coal.

Generation of Electricity

The electric consumption by meter proves to be 2,622,000 kilowatts per year. There is little monthly variation in the electric cost, as evidenced by the bills. Electricity has cost the owner, purchased from the public service company, about $58,000.00 per year, or 2.28 cents per kw-hr. It was used for lights, for elevators, for fan motors, and for laundry and kitchen small motors. The peaks swing up to over 600 kw momentary demand.

Refrigeration is supplied by steam-driven compressors.

An electric generating plant for a building of this type should be designed so that the exhaust steam will all be condensed in the heating system or in the water heating system. To the extent that such double use can be made of the steam, only, will it be more economical usually to operate an isolated plant than to purchase electric energy.

As long as all of the exhaust steam from the engines which drive the generators can be condensed usefully, the plant can make its own electricity at a cost which almost vanishes, so far as fuel is concerned.

Thus in January of any year, all that the electricity will cost will be extra engineer's labor, lubricating oil, interest and depreciation. In July of any year, however, only such steam can be condensed as the hot water heating demand may absorb, and all surplus exhaust steam must be wasted.

The following table of monthly steam volume when the plant generates its own electricity, set against the monthly condensing capacity derived from the heating and hot water load, will serve to visualize this matter:

Col. 1	Col. 2	Col. 3	Col. 4
January	16,500,000 lbs.	7,200,000 lbs.	18,500,000 lbs.
February	13,400,000	7,200,000	15,400,000
March	11,500,000	7,200,000	13,500,000
April	7,695,000	7,200,000	9,695,000
May	3,280,000	*7,200,000	8,200,000
June	2,000,000	*7,200,000	8,200,000
July	2,000,000	*7,200,000	8,200,000
August	2,000,000	*7,200,000	8,200,000
September	2,000,000	*7,200,000	8,200,000
October	5,780,000	*7,200,000	8,200,000
November	10,240,000	7,200,000	12,240,000
December	10,785,000	7,200,000	12,785,000
Total	87,180,000	86,400,000	131,315,000

*More steam than can be condensed.

Col. 1—Month.

Col. 2—Condensing capacity of the plant for exhaust steam from electric generating engines after deducting for high pressure steam demand, 1,000,000 pounds per month, and for exhaust from existing auxiliaries such as pumps, 1,000,000 pounds per month.

Col. 3—Steam required per month, using steam engines at 32 lb. per kw, 225,000 kw monthly demand.

Col. 4—Total steam required per month using steam engines to generate electricity. Combination of monthly heating demand and Col. 3.

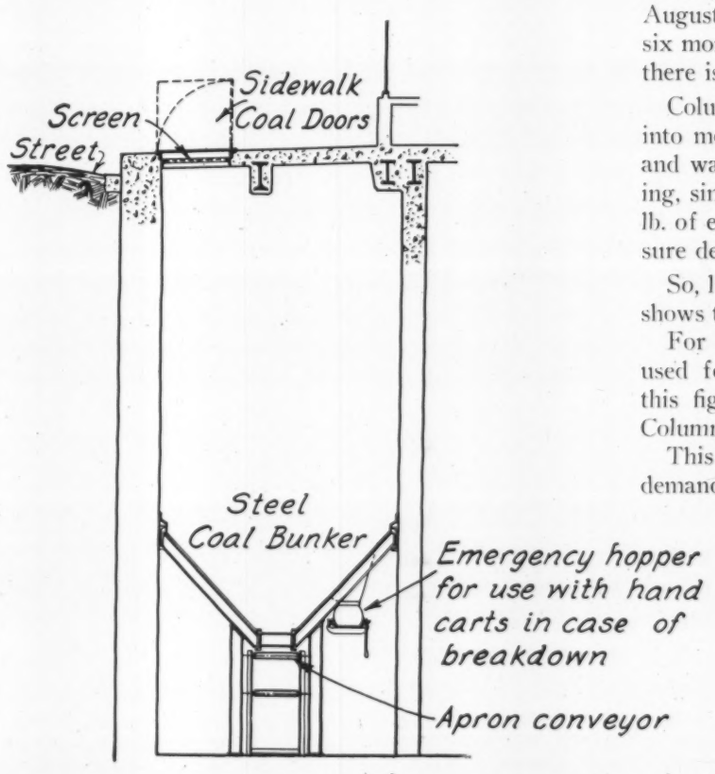
In other words, all the exhaust steam made as a by-product of electric generation might be condensed considering the yearly total of Columns 2 and 3, but unfortunately this cannot be done during May, June, July, August, September or October, while during the other six months much more exhaust steam could be used than there is available.

Column 4 shows the total yearly steam demand divided into months. For January the load is that for heating and water and process work, such as laundry and cooking, since this load from Column 1 exceeds the 7,200,000 lb. of electric exhaust plus the 1,000,000 lb. of high pressure demand.

So, likewise for February, March and April, Column 4 shows the total steam demand to be that of Column 1.

For May, however, 7,000,000 lb. of steam must be used for electricity and 1,000,000 lb. for process, and this figure of 8,200,000 lb. must be the May total in Column 4, since it exceeds the 5,280,000 lb. of Column 1.

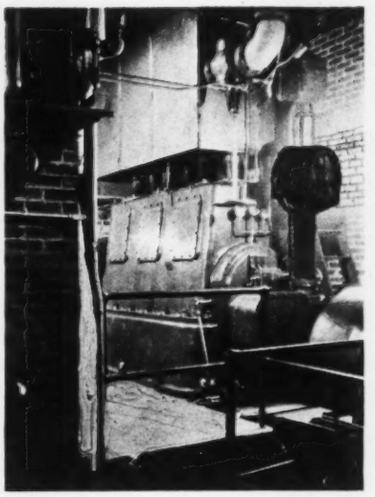
This gives, at the end of the year, an annual steam demand, if electricity is generated, of 131,315,000 lb.



In Case of Break-Down in the Coal Conveying System, There Is an Emergency Manually-Operated Hopper Door and Coal May Be Wheeled in Carts via a Platform Elevator, for Final Discharge into the Hoppers

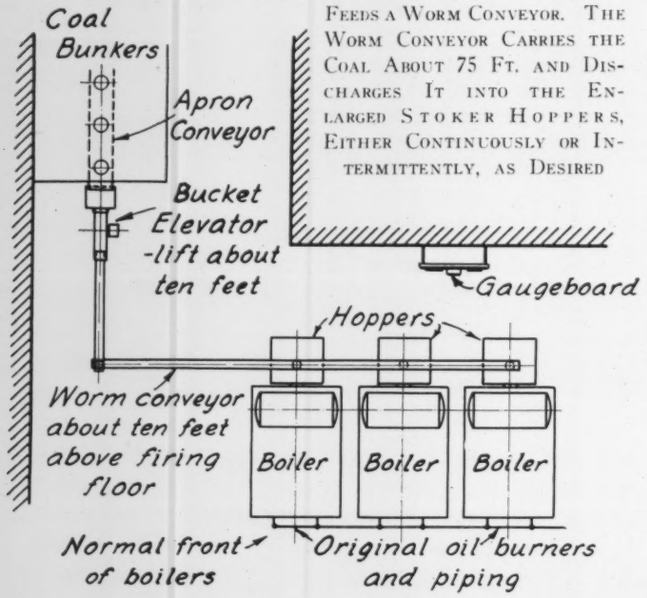
of steam, this being 20,135,000 lb. in excess of the requirement if electricity is not generated.

Now, if 111,180,000 lb. of steam cost $38,000.00, or say, 35 cents per 1,000 lb., the 20,135,000 extra pounds will not cost any more per thousand to make using the same plant, but should cost less, since the items of maintenance and labor can be divided by a larger output unit.



RIGHT—ONE OF THE HIGH SPEED VERTICAL, THREE-CYLINDER UNIFLOW ENGINES WHICH DRIVES AN ELECTRIC GENERATOR

BELOW—AN APRON CONVEYOR UNDER THE HOPPER-BOTTOM COAL BUNKER FEEDS A BUCKET ELEVATOR, WHICH IN TURN FEEDS A WORM CONVEYOR. THE WORM CONVEYOR CARRIES THE COAL ABOUT 75 FT. AND DISCHARGES IT INTO THE ENLARGED STOKER HOPPERS, EITHER CONTINUOUSLY OR INTERMITTENTLY, AS DESIRED



To be very liberal, however, let us assume that the original 35-cent unit cost will apply, and that the steam cost, aside from interest and investment and labor for all of the electricity for a year will be 20,135,000 lb. at 35 cents per thousand, or $7,047.25.

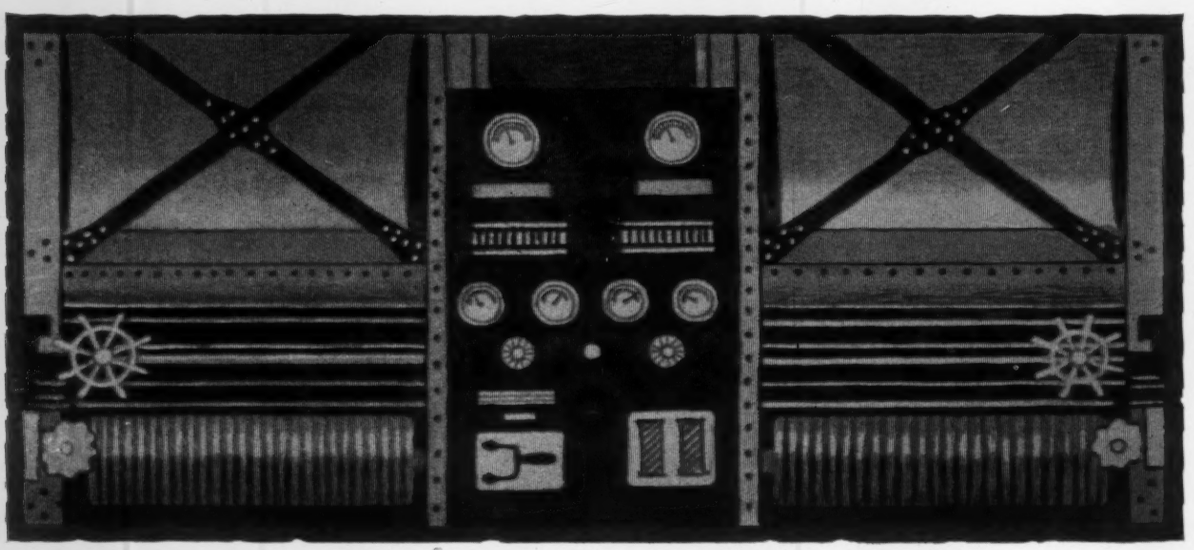
The investment cost for the electric equipment, consisting of two 450 kw generators with uniflow engines and all auxiliaries was $80,000.00. Allowing 6 per cent interest ($4,800.00), and 5 per cent depreciation ($4,000.00), and allowing an extra man per shift, a carrying charge of, say, $15,000.00 per year is obtained, or a total cost for electricity of $22,047.00 per year against the $58,000.00 per year formerly paid to the public service company.

The result of this adventure into engineering, so far as the owner is concerned, was as follows:

Annual cost with oil and purchased electricity	$133,000.00
Annual cost with coal and manufactured electricity	60,000.00
Annual saving applicable to dividends	$ 73,000.00 ($200.00 per day)

A recent check-up indicates that the plant is now burning a grade of coal costing but $2.75 per ton, and that the saving on electricity alone, with this less costly fuel, is running around $200.00 per day, exclusive of the saving of over $100.00 per day by substituting coal for oil.

This example does not prove (and it is not the intention to do so) that coal is a superior fuel to oil or gas. It does indicate, however, the necessity of an engineering analysis and competent engineering advice if the mechanical equipment of a building or an industrial plant is to be operated as economically as is possible. Obviously, with another combination of circumstances, the engineering analysis might have shown that oil or gas should be used.



Air Piping for Signal and Other Uses in Philadelphia Subway

By Richard H. Borngesser*

PHILADELPHIA'S newest transportation facility, the Broad street subway, built by the city at a cost of approximately $90,000,000, represents another forward step in meeting the demand for high-speed transit service in this Pennsylvania metropolis. In this subway is located a piping system small in comparison with the total structure but vital in importance. This piping system supplies air for the operation of many important pieces of apparatus necessary to the operation of high-speed transit trains, some of the more important being track switches, automatic train stops, circuit breakers, whistles and all manner of track tools.

Piping systems such as the one installed in the Broad street subway are not very numerous throughout the country, although there are many small installations of a similar nature installed on steam railroads. Piping systems similar to the one installed in the Broad street subway are in service in several of the Interborough Rapid Transit Company's subways in New York, and as many of the problems solved are met with in industrial plants of all kinds, a description of the system will prove valuable to piping engineers and maintenance men in all fields.

Layout and Location of Main Air Line

The layout scheme of the piping system is as follows: Starting at the southerly limits of the subway (South street), there has been installed one main air pipe line, two inches inside diameter, located on the center row of columns of the structure between the two future express tracks. This line is constructed of copper steel pipe and is of extra heavy construction, galvanized both inside and outside. The limit of this installation is City Hall, a distance of some 3600 feet from South street. This section of piping is fed by single-stage, water cooled air compressors in duplicate, 75 c. f. m. capacity, 100 lb. per sq. in. displacement located at Manning street, approximately halfway between the limits of the pipe installation.

Starting at City Hall and continuing northward to the limits of the subway (Grange avenue) the pipe installation has been made similar to the one above, the location and size being the same. However, this line is constructed of extra heavy wrought iron pipe, galvanized inside and outside. The extent of the latter installation is some 38,000 feet. This section of piping is fed by single stage, water cooled air compressors in duplicate located at Ridge-Fairmount, Erie avenue, Olney avenue and the Yard Portal. The first three mentioned are of the 75 c. f. m. size and the last one is of 100 c. f. m. capacity, 100 lb. per sq. in. pressure. From Grange avenue to and including the yard there is one continuous loop serving both north and south yards, with two-inch gate valves so located that the line in the yard can be sectionalized every 300 feet or so. Fig. 1 shows the layout and location of the main air line. The line through the yard is supported by concrete pedestals spaced every seven feet and approximately two feet above the ballast level. Through the subway, special brackets clamped to the columns were provided for supporting the main air pipe. In Figs. 2, 3, 4 and 5 may be seen some of the methods of supporting this pipe and the guides and supports for expansion bends, reservoirs, etc.

Size of Pipe and Its Uses

The size of the main air pipe was determined after much study with regard to the apparatus to be operated, the air capacity necessary to operate it and the number of times it would be operated in

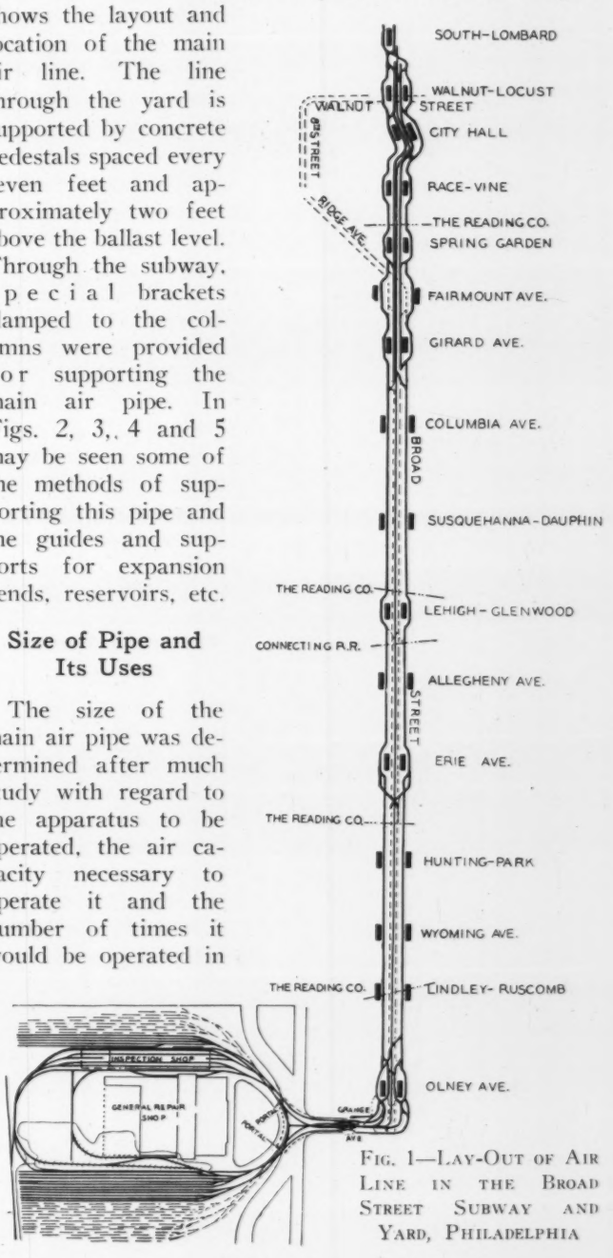


FIG. 1—LAY-OUT OF AIR LINE IN THE BROAD STREET SUBWAY AND YARD, PHILADELPHIA

*Dept. of City Transit, Philadelphia.

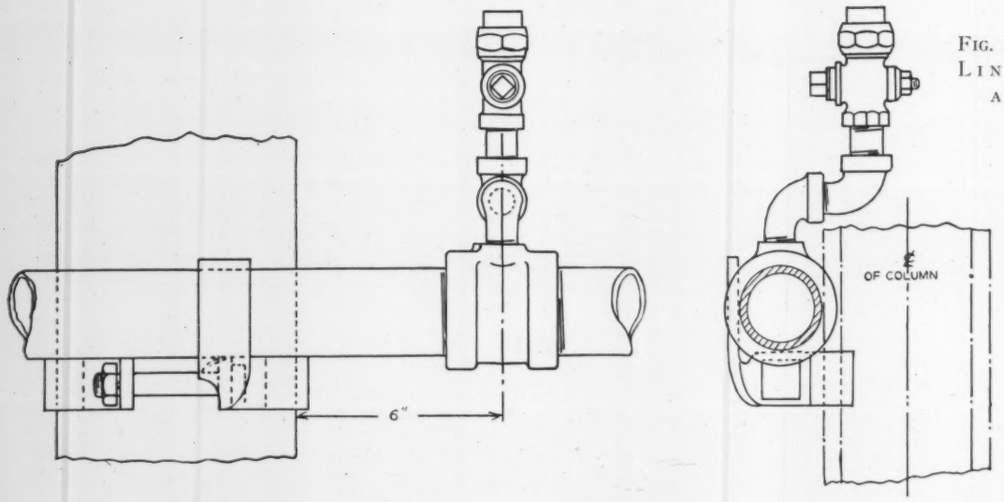


FIG. 2—MAIN AIR LINE — SUPPORT AND GUIDES

a twenty-four hour cycle. Also, the mechanical strength was considered, frictional resistance, and the reservoir capacity of some 40,000 odd feet of two-inch pipe, thus eliminating, along the line, the use of large reservoirs which are unnecessary with the use of a large-size air pipe main.

The loss of pressure due to frictional resistance per 1000 feet in two-inch pipe amounts to 0.71 lb. However, one must not forget that small reservoirs are used along the line for condensation purposes. All branch lines are of the ¾-in. and ½-in. sizes, the ¾-in. size being spaced at intervals of 200 feet and used as service taps to provide for the operation of pneumatic tools to do concrete cutting, tie boring, screw spike driving, etc.; for the operation of track switches; for operation of air circuit breakers, remotely controlled from the various substations; and for the operation of whistles.

The ½-in. size is used for the operation of automatic train stops, of which there is a very large number, operating at frequent intervals.

The above applies only to the subway. In the yard, in addition to the foregoing, ¾-inch taps are provided for tie tamping, snow cleaning, etc. The following list of equipment with the operating air requirements was used as a basis for computing the size of air line and the size of compressors which were required for the system:

	Cu. Ft. Free Air per Min. (Approx.)
Subway track switches	0.40
Yard track switches	0.75
Automatic train stops	0.10
Circuit breakers	0.23
Pneumatic tools, etc.	17.00
Two-inch pipe line, per mile	5.00

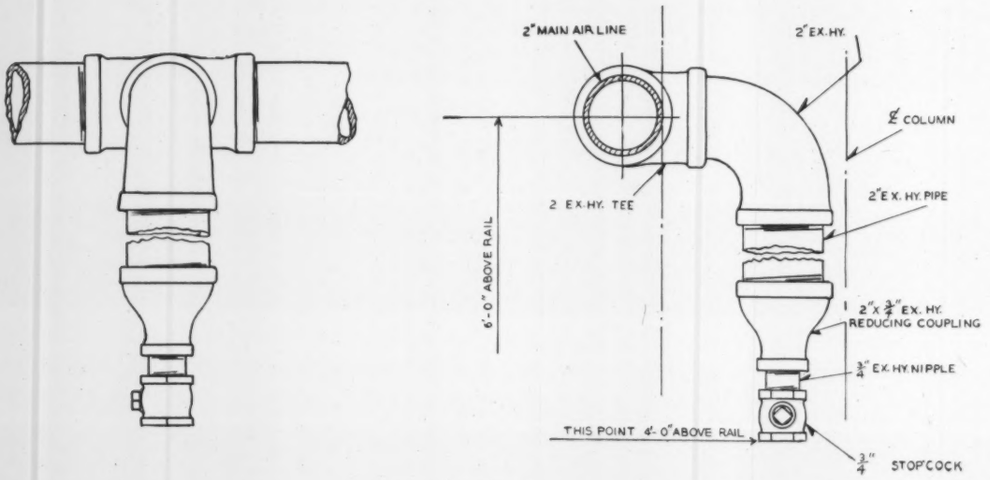
Air Pressure Requirements

Various pressures are required for the different apparatus; track switches operate on an air pressure of from 30 to 50 lb., automatic train stops require a pressure of 60 to 70 lb., circuit breakers require approximately 65 lb., and air operated tools require as high as 80 lb. Evidently, the automatic governors for compressors need quite a range of operation. The governors on this line are set to automatically cut in at a low pressure of approximately 60 lb. and cut out at a high pressure of 80 lb. This covers very well the range of operation.

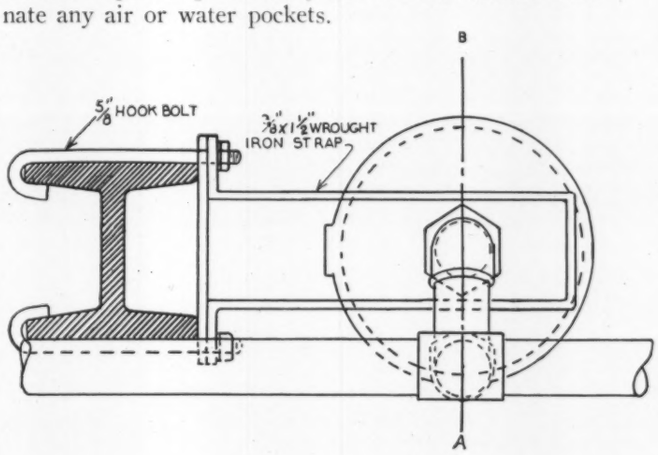
Installation Requirements

The main air pipe had to be installed according to the grade of the subway, and to do so the line had to be laid out and installed with a regular profile guide. Grades were encountered anywhere from 0 to 3½ per cent.

FIG. 3—MAIN AIR LINE—SERVICE TAPS



Pipe risers had to be installed where the line interfered with station structures, special structural conditions, etc. All this required special study and consideration to eliminate any air or water pockets.



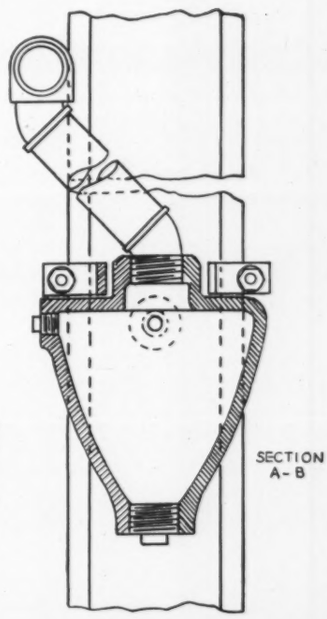


FIG. 4—AIR LINE DRAINAGE RESERVOIRS. ALL PARTS GIVEN ONE COAT OF RED LEAD OR RED OXIDE BEFORE PUTTING IN PLACE, AND TWO COATS TO MATCH THE PAINT ON ADJACENT IRON WORK AFTER PUTTING IN PLACE

At each low point in the main pipe line, auxiliary reservoirs had to be installed to provide for drainage. All branch lines leaving the main pipe line, furthermore, had to be connected to the upper side of the line so that any condensation could never enter these branch lines. Periodically, these auxiliary reservoirs are blown off. Proper drainage for any main pipe line is of the highest importance to the signal system.

Temperature Conditions—Expansion and Contraction

Due to the small changes in temperature encountered in a subway, the expansion and contraction problem is not a difficult one. However, in the yard, the case is entirely different.

In the subway, to allow for expansion and contraction, double offset "U" expansion bends, having a radius of 24 inches, were used. These were connected to the upper side of the main pipe line. As the subway structure roof is approximately 13′-6″ above the top of rail, the use of the expansion bend located the height of the main pipe line, which is approximately 6′-0″ above the top of rail. Expansion bends are located approximately every 700 feet and are properly anchored with two substantial anchors, as shown in Fig. 6, half-way between two bends. Two-inch gate valves are placed two feet on the north side of the bends and make it possible to sectionalize the lines, should conditions demand it.

When pipe risers were necessary to provide for proper expansion, hinge joints were made of two or more

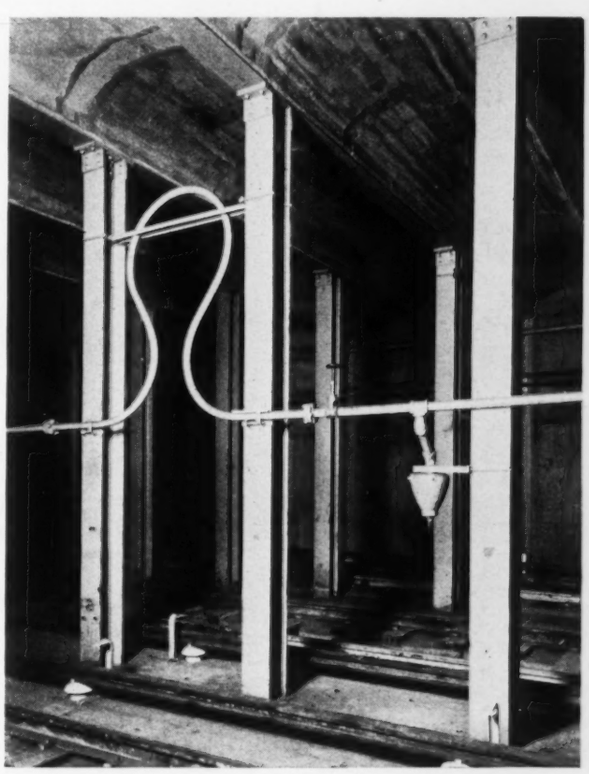


FIG. 5A—AN EXPANSION BEND AND DRAIN COCK

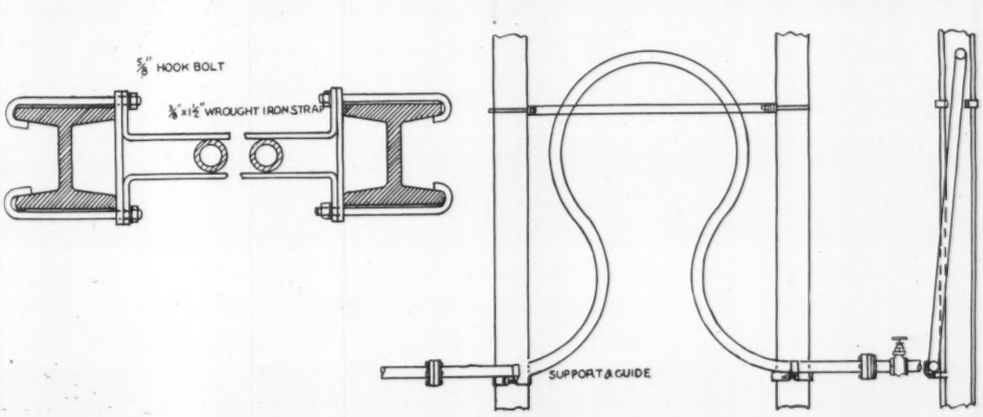


FIG. 5—MAIN AIR LINE EXPANSION BEND. THE DETAIL SHOWS THE EXPANSION BEND SUPPORT

street ells which took care of the situation. In the 350 feet allotted for expansion and the degree variation of temperature, the above line travels approximately 1 to 1½ inches only. In the yard, where the main pipe line is subjected to extreme temperature, slip joints of the expansion type were used to allow for large line travel. Anchors, mounted on concrete pedestals, were used to hold the line between expansion joints. Alcohol is used in the winter time in the yard line to prevent condensation from freezing and blocking the line.

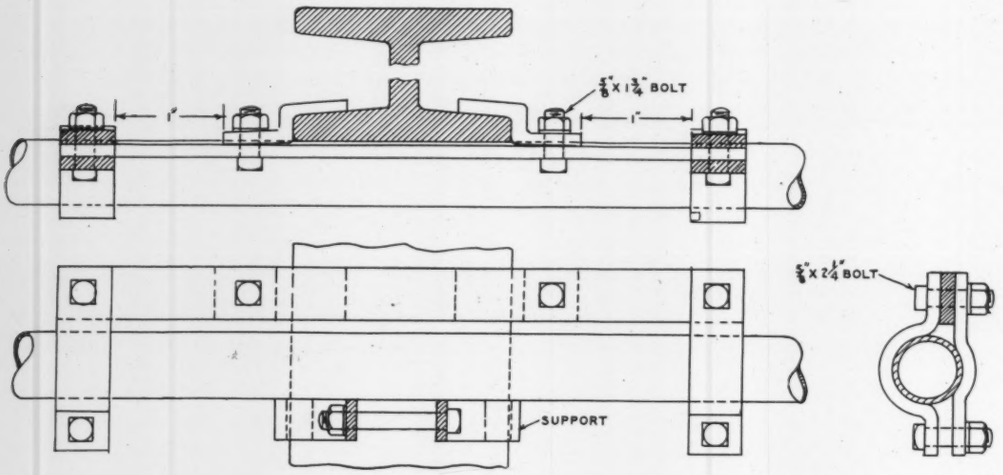


Fig. 6—Main Air Line Anchor, Installed on Column Nearest Center Between Expansion Joints. All Straps Are of ½ In. by 2 In. Wrought Iron

Sediment Chamber

The small volume of air conveyed by any branch pipe every 24 hour cycle not only contains but little moisture but its velocity, when flowing, tends to carry with it any moisture that it may have deposited during the period of no flow. To avoid an objectionable amount of condensation thus reaching the valves and ports of apparatus of the signal system, or any other apparatus, and to arrest any particles of sediment that may be within the pipe and carried by the air, a combined sediment chamber and strainer is employed at the terminal of each branch pipe where it joins any operating mechanism. This device is provided with a blow-off cock for expelling the sediment and moisture as collected.

Piping of Manifold Condensers

After coolers of the air cooled type (termed manifold condensers) are used to cool the compressed air for this system. These vary in capacities to meet the require-

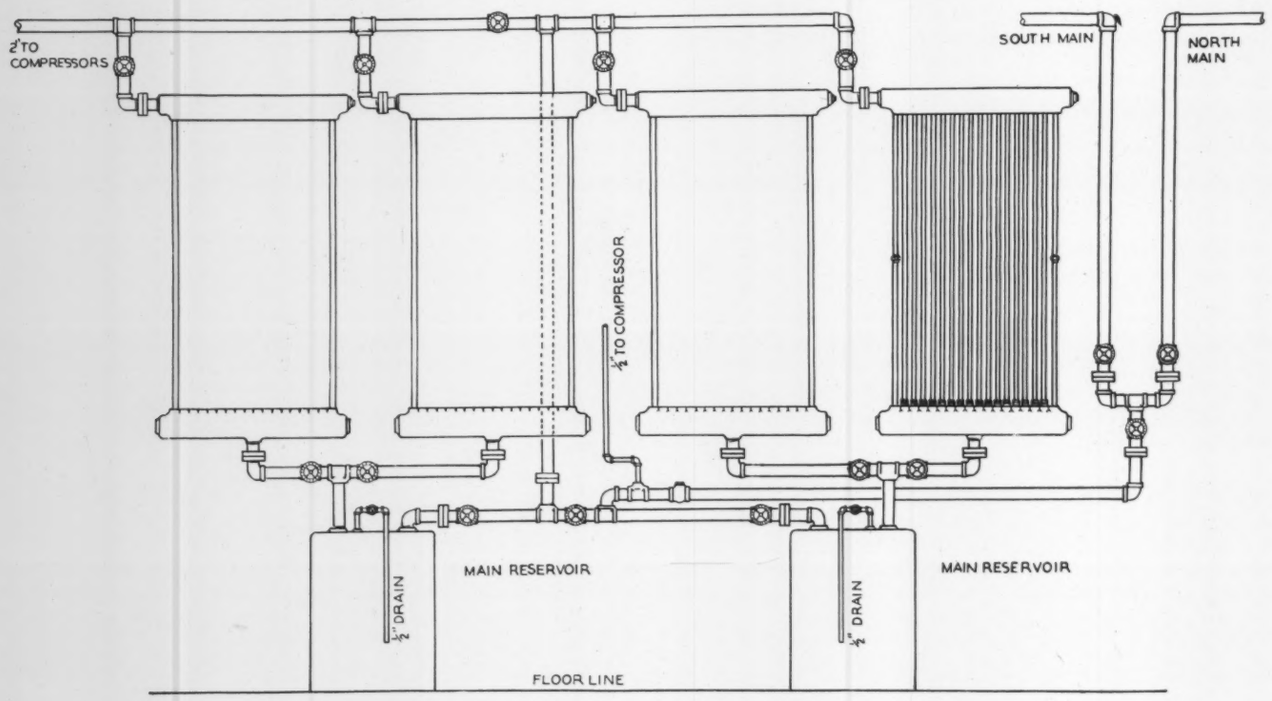


Fig. 7—Schematic Diagram of the Manifold Condenser Lay-Out

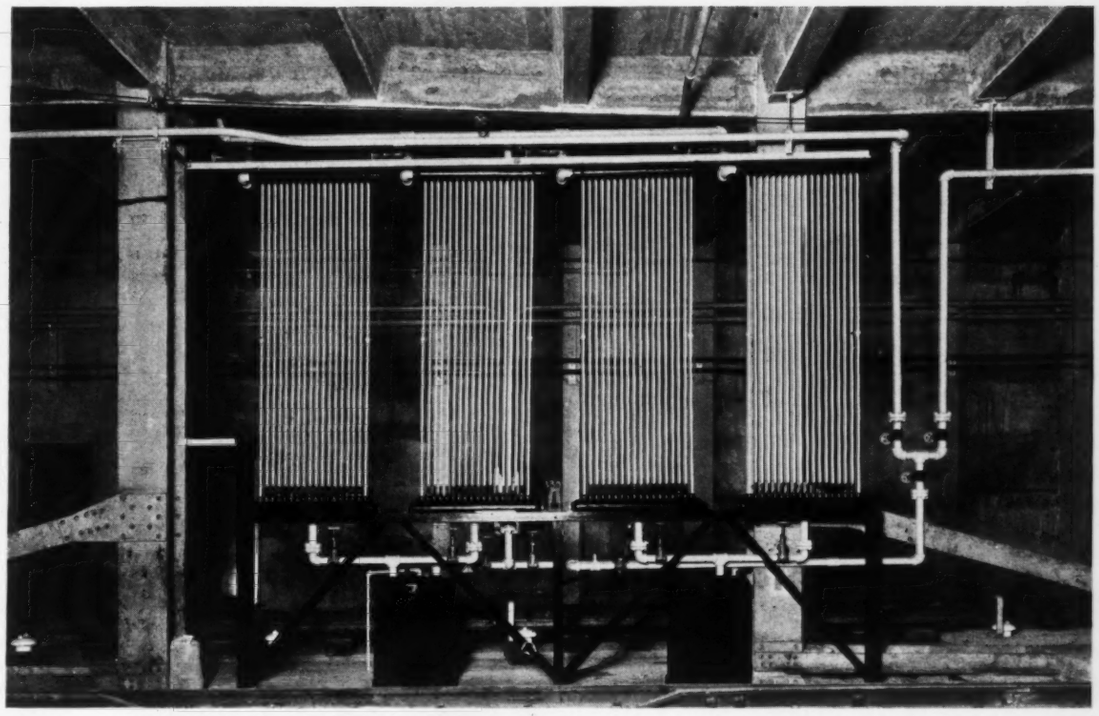


FIG. 8—THE CONDENSERS AND STORAGE TANKS

ments of the maximum volume of air to be delivered to the system at any time, and vary in dimensions occasionally to meet peculiarities of their location. The make-up of the manifold condenser shown in Fig. 7 is as follows: The piping from the compressors to the manifold condensers is two-inch pipe galvanized inside and out. This size is also used from the condensers to the main reservoirs and to the main line. The condenser itself is made up of four-inch cast-iron headers shown at top and bottom, and the top one is drilled and tapped to take the one-half inch steel pipe risers. The bottom header is drilled only and slip joints which are packed with compound are provided for expansion and contraction of these small pipe risers.

Two sets of condensers cool the air from one compressor, the other two sets taking care of the other compressor. One main reservoir takes the precipitate of two condensers, as shown, and a blow-off cock is provided on each reservoir so that any excess condensation may be blown off.

These reservoirs are also used as storage tanks to keep the air pressure stable. Bypasses are provided around the individual condensers (as shown Fig. 7) so as to permit repairs, etc. to these devices, when needed, without interrupting the compressed air supply to the piping system.

Piping for Compressors

The piping for the compressors is made up of ½-in. and 2-in. air lines and ½-in. and 1¼-in. for water supply, these compressors being water cooled. The ½-in. air lines serve the governor control on the switch-board, also the air pressure gage on the switch-board. A ½-in. line comes direct from the manifold condensers so that pressure may be read direct off the main air line.

Sight feeds in the water lines determine whether or not the water is circulating through the compressors. A safety valve is located as near the compressor as practicable, but no valve intervenes between it and the compressor. The air pressure gage mentioned above is connected with the service main where this joins the cooling system, thus giving this connection not only an accurate reading of the pressure in the service pipes, but it also avoids the violent action of the index hand of the gage that accompanies its location close to the compressing cylinders, due to the pulsation of the compressors.

Cooling of Buildings

Generally speaking, there are two methods of cooling applied to air conditioning; one is by evaporation of water into the air of a room and the other is by the use of refrigerants which are evaporated in refrigerating machines. As these refrigerants are used over and over again after they have been evaporated, they are brought back to their original liquid state by a process of condensation.

Cooling by Evaporation Is Limited

There is a limit to which air can be cooled by evaporation of water. The extent of the possible cooling depends upon the wet bulb temperature which indicates the degree of moisture in the air. The greatest cooling may be obtained in dry air. That is to say, the extent of cooling bears relation to the amount of vapor the air will absorb. Moist air can be cooled to a less extent and saturated air cannot be cooled by this means at all. Wet bulb depression is used to determine how much cooling may be had by evaporation. Wet bulb depression is the difference between wet bulb and dry bulb temperatures.

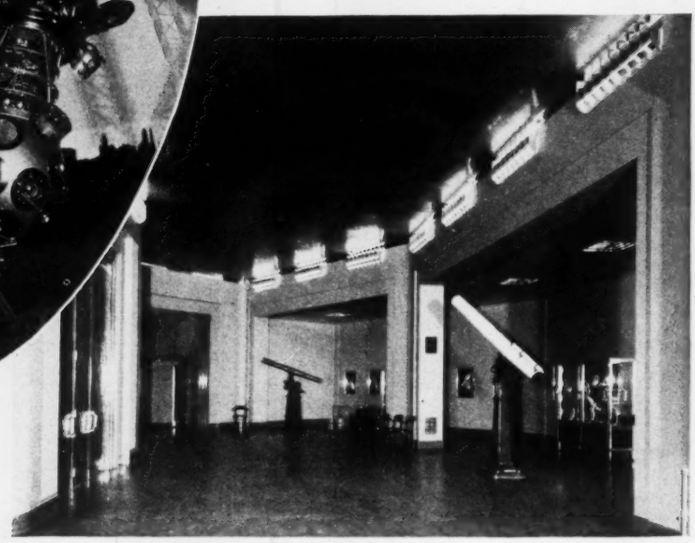
Modernistic Design

a feature of new

Chicago Planetarium

AIR IS INTRODUCED TO THE NORTH AND SOUTH EXHIBITION HALLS OF THE CHICAGO PLANETARIUM THROUGH COMBINATION LIGHTING FIXTURES AND INLETS, THREE OF WHICH MAY BE SEEN TO THE LEFT. THE EXHAUST GRILLES ARE SHOWN ON THE FAR SIDE OF THE ILLUSTRATION. 12,200 C.F.M. IS SUPPLIED TO THE EXHIBITION HALLS

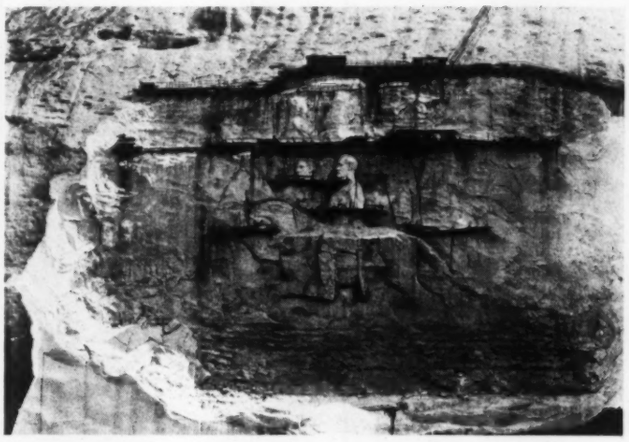
THE OVAL VIEW IN THE CENTER SHOWS THE PROJECTOR, WHICH THROWS BEAMS OF LIGHT ON THE CANVAS DOME OF THE CENTRAL CHAMBER TO REPRESENT THE STARS IN THEIR COURSES. AS ABSOLUTE CLEANLINESS OF THE DOME IS ESSENTIAL, AIR TO THE PLANETARIUM CHAMBER IS WASHED AND FILTERED



THE INLET AND OUTLET FOR THE CONCEALED RADIATION LOCATED IN THE COLUMN MAY BE SEEN BELOW. ALSO NOTE THE LOCATION OF LIGHTS IN BOXES TO GIVE MODERNISTIC LIGHT AND SHADOW EFFECTS OVER THE GOLD CEILING. ARCHITECT, ERNEST A. GRUNSFELD, JR., AND CONSULTING ENGINEER, MARTIN C. SCHWAB, BOTH OF CHICAGO

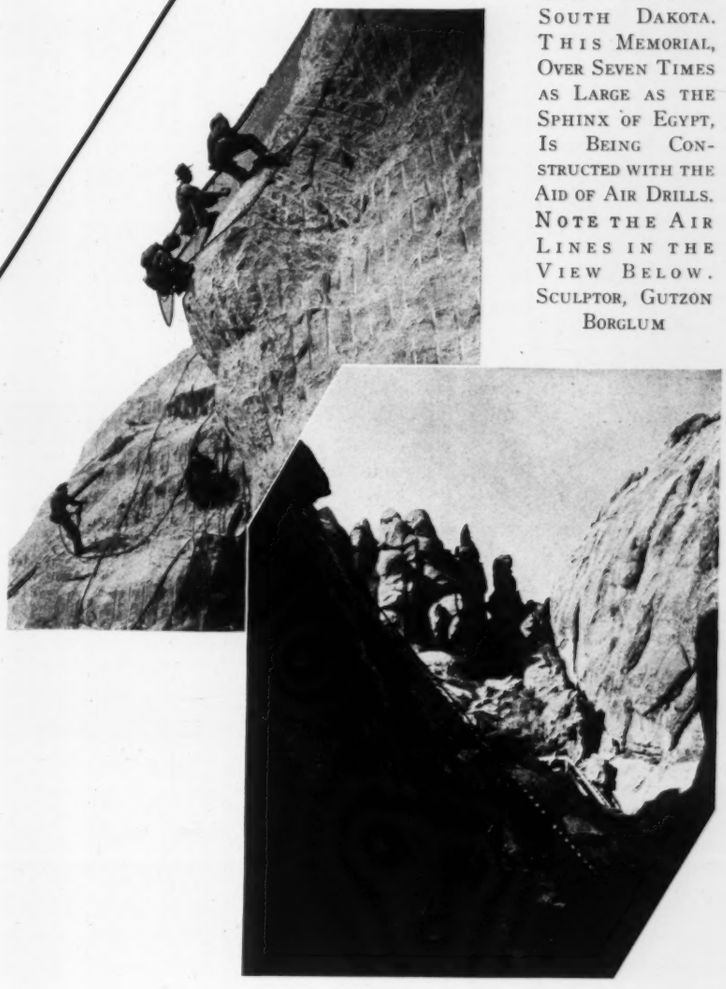
ABOUT 7½ FT. ABOVE THE FLOOR LINE ALL AROUND THE CENTRAL CHAMBER ARE BLACK LOUVRES, ARRANGED TO "KILL" THE STARS SHOULD THE MACHINE BE SLIGHTLY OUT OF ADJUSTMENT IN A WAY TO CAUSE THEM TO SHOW BELOW THE HORIZON LINE. THE HEATING ENGINEER TOOK ADVANTAGE OF THESE LOUVRES, AND INTRODUCES THE AIR THROUGH EIGHT INLETS ON THE SOUTH SIDE AND EXHAUSTS IT THROUGH EIGHT OUTLETS ON THE NORTH SIDE, LOCATED IN THE LOUVRES. 10,000 C.F.M. IS SUPPLIED TO THE PLANETARIUM CHAMBER; ABOUT 10 PER CENT LESS IS EXHAUSTED. A UNIT HEATER IS LOCATED AT THE BUILDING ENTRANCE TO HEAT THE VESTIBULE

Memorials and Mountains



Compressed Air Lines May Be Seen in the Early View (Above) of the Work on the Confederate Memorial at Stone Mountain, Near Atlanta, Georgia

The Piping Engineer Co-operates with the Sculptor in Carving the World's Greatest Memorial on the Face of Mt. Rushmore, in the Black Hills of South Dakota. This Memorial, Over Seven Times as Large as the Sphinx of Egypt, Is Being Constructed with the Aid of Air Drills. Note the Air Lines in the View Below. Sculptor, Gutzon Borglum



WE CAN'T ESCAPE THE WEATHER OUTDOORS; BUT WE CAN "TAILOR IT TO MEASURE" INSIDE. HOW MANY PEOPLE IN THIS CROWD WOULD STOP AT AN AIR CONDITIONED STORE TO SHOP RATHER THAN ONE OFFERING THE SAME ATMOSPHERE THEY ARE NOW ENDURING?

Controlled Indoor Atmosphere

What the Weather Can Do and What Can Be Done with the Weather

Article No. 3

By Perry West*

IT IS often, and very truthfully, said that we are creatures of our environment, and it might be added that the weather is the most persistent environment with which we are usually associated. It is the most universal topic of our conversation, the most generally suspected reason for our depressions and shortcomings and the most frequently accredited cause of our elations and accomplishments. Yet as a matter of fact less than 10 per cent of the weather with which nature endows us could be truthfully pronounced perfectly satisfactory.

The optimum atmospheric condition for the comfort and health of a normal adult normally clothed and slightly active is from 67 to 69 F dry bulb temperature, 25 to 50 per cent relative humidity, 25 to 50 f.p.m. air motion and comparative freedom from dust, bacteria and objectionable odors. Nowhere on earth, either indoors or out of doors, except in some favored islands, do these conditions exist naturally for more than 500 out of the 8760 hours of the year, and in most locations the proportionate duration of any such ideal natural conditions is far less. As paradoxical as it may sound, it is not generally the existence of these optimum conditions, or of the conditions furthest removed therefrom, but rather the sudden changes from one condition to another, which bring about the greatest comfort and relief or cause the greatest discomfort and suffering so far as natural weather conditions are concerned. This is true, not because continuous ideal weather conditions would prove anything but most comfortable and healthful, but because these ideal conditions exist for such a small part of the time that their impress is lost sight of in comparison with the impressions which we receive from the rapid changes from one uncomfortable condition to another.

Variations Give Temporary Relief

We are told by some who have engaged in long research and study of the effect of natural climatic conditions upon the comfort, health and happiness of human beings, that a climate with moderate variations is best.

It is also frequently claimed that even the wider variations in climatic conditions have their advantages as well as their disadvantages, and in the blizzard, the ice storm, the great electric disturbances, the hurricane, the torrential rain or the sweltering heat of the tropics may be found many factors which are beneficial to our comfort and health.

The probabilities are that variations are beneficial under natural weather conditions more as a temporary relief or stimulation from the strain of one uncomfortable condition or another and not in comparison with continuous ideal conditions.

These will all be discussed in order, but let us pause at this point to observe that in this age of our highly organized and swiftly moving complexities of life, we are finding it more and more necessary to control our indoor

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Man cannot do much about the weather out-of-doors, save to predict what it is going to be. Inside, however, he may make it what he wishes

atmospheric conditions along the lines of such standards as have been found to be best suited to the health and comfort of our people and to the proper and most economic scheduled mass production of our industrial products.

Effects of the Climatic Zones

The climate of the Frigid Zone tends to produce hardy specimens of those who withstand it, but there are few who can survive its rigors. The soil is non-productive, more on account of the unfavorable climate than for any other reason. The lands within these zones throughout the world are sparsely populated, industry remains undeveloped and such rich fields of natural resources as exist in Siberia, in the lands north of Canada and in the lands surrounding the South Pole remain practically unworked, principally on account of the unfavorable climate.

The climate of the Torrid Zone saps the energy, enervates by over-heating and reduces the vitality of the inhabitants to such an extent that, notwithstanding the extreme fertility of the soil and its abundant productivity under such a climate, the lands within this zone remain but partly developed and with populations and industries far below the standards of the Temperate Zones.

The climate of the Temperate Zones constitutes the most important difference between these and the other zones, as far as the comfort and health of the inhabitants are concerned, and is more responsible than any other one factor for the much greater density of population and thus for the far greater development of all kinds of industries in the lands within these zones than exist in other lands.

Climatic Variations Within the Same Zone

In addition to the effects of the climatic conditions of the different zones upon the health, comfort, life and activities of people, already mentioned, there are many other important effects which the different natural climatic conditions within any particular zone exert upon the habits and activities of the people within that zone.

Taking our own Temperate Zone within the United States as an example, we find that, while cotton is grown in the hot dry atmosphere of the South, it has been most successfully spun and woven (in past years) in the moist cool atmosphere of the north, so that cotton has been grown in one place and transported to textile mills thousands of miles away simply on account of the natural climatic conditions.

All of the ingredients for sugar and candy are grown in the Torrid Zone, but most of our sugar and candy is manufactured in the northern part of the Temperate Zone because climatic conditions in this zone, in the first place, have been responsible for the development of the necessary refining and manufacturing industries, along with other industries, and in the second place, have afforded better natural atmospheric conditions for the processes themselves.

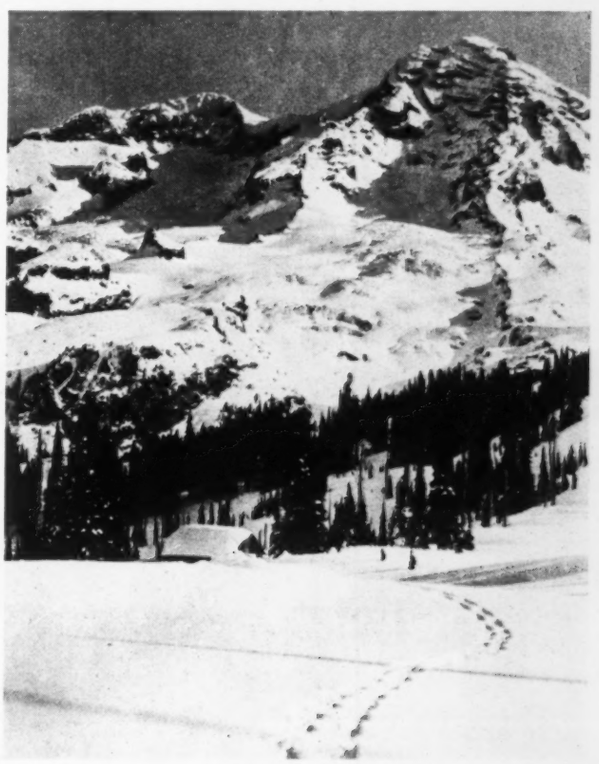
Glass is manufactured in the East, where proper sand and fuel are available, but certain kinds of shatter proof plate must be fabricated in a dry atmosphere such as that in Colorado.

Tobacco is grown in the South, but was generally manufactured in the North on account of climate and climatic responsive industrial conditions, until quite recent air conditioned factories made it possible to manufacture where the product is grown.

Grain is grown in one place and milled in another, hides are produced far from where they are tanned, shoes and other leather goods are manufactured in other localities, hemp and flax are grown and manufactured in different places and substantially the entire list of products are transported far from field to manufacturing plant chiefly on account of climatic influence, either upon the processes themselves or upon the activities of people in the location of industries.

Seasonal Changes

Most every climate has its rainy seasons, its dry seasons and its stormy seasons.



This Scene Looks Rather Cool and Peaceful; We Can Have the Same Sort of Weather in Our Public Buildings, Offices, Homes and Industrial Plants All Summer with Air Conditioning

The northern climates have seasons of extreme cold with corresponding low absolute humidities, and the southern climates have seasons of extreme heat with corresponding high absolute humidities. All climates are

MANY ENGINEERS SAY LIGHTNING PURIFIES THE ATMOSPHERE; WE CAN DO IT INDOORS, EITHER WITH ELECTRICITY OR BY SOME OTHER METHOD

subject to seasons of high relative humidity and most climates to seasons of low relative humidities.

Weather Phenomena

In addition to the wide differences in weather conditions throughout the different temperature zones of the earth and the wide seasonal variations throughout any particular zone, there are other important variations due to such weather phenomena as storms, extreme cold spells, extreme hot spells, spells of high humidity, spells of low humidity, sunshine and cloudiness.

Electric storms, which occur most frequently in the warmer climates or during the warmer seasons of the colder climates, generally clear the atmosphere, produce precipitation, reduce absolute and relative humidities and add to the concentration of ozone in the atmosphere. Rain storms produce much the same results as electric storms.

Wind storms may bring in an entirely different atmosphere from some other location, churn up a local atmosphere and by admixture with other air change its entire character. This generally reduces relative humidities, tends to remove cloudiness and prevents local stagnations.

Cold spells reduce absolute humidities out-of-doors and where indoor temperatures are appreciably higher than outdoor temperatures the relative humidity indoors will be reduced, although the outdoor relative humidity may remain more or less constant or frequently be increased.

Hot spells usually increase absolute humidities and frequently increase relative humidities in the presence of moisture, but may decrease thes relative humidities when accompanied with dry conditions.

Sunshine increases the vital properties of the atmosphere, usually decreases relative humidity, takes away the raw, chilling effect of a damp, cold atmosphere by warming and reducing its relative humidity and reduces the sweltering effect of a hot moist atmosphere by a similar reduction in relative humidity. The psychology of sunshine, together with what remains somewhat of a mystery as to its ionization or ultra ray action, are highly beneficial to the health and comfort of human beings.

Cloudiness, of course, has the reverse effect of sunshine.

Physiological and Industrial Processing Effects of the Weather

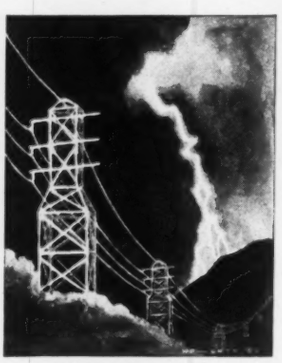
We are speaking here particularly of the effects of the weather upon the health, comfort and activity of people and upon the various processes used in the industries. It might be well to sum up at this point by enumerating some of the specific effects of the various weather conditions, already referred to, upon these particular phases of the social and industrial life of people throughout the world.

We have already referred to the fact that natural atmospheric conditions are far from the optimum so far as the health and comfort of normally clothed people living indoors are concerned, and while some of the outdoor conditions are reasonably met by adjustments in the weight of clothing and by the use of other protective measures, there are few locations where reasonable indoor conditions exist for more than a small percentage of the time unless artificial means are employed to condition the atmosphere very differently from what would result from natural out-of-door conditions.

Winter conditions in the Frigid Zone range from 75 F below zero with practically no moisture, to zero with three grains of moisture per lb. of air. The optimum comparable with this is 60 F, with 40 grains of moisture.

Summer conditions in this zone range from 10 to 50 F with from 10 to 50 grains of moisture, while the optimum is 65 F with 45 grains of moisture.

In the north Temperate Zone the winter conditions range from 40 deg. below to 40 deg. above zero with from practically none to 25 grains of moisture, averaging 10 deg. with 5 grains of moisture, while the optimum is 68 deg. with 45 grains of moisture.



The winter conditions in the south Temperate Zone are from 30 to 70 deg. with from 15 to 50 grains of moisture, averaging 50 deg. with 30 grains of moisture, while the optimum is 70 deg. with 40 grains of moisture.

The summer conditions in the north Temperate Zone are from 50 to 90 deg. with from 30 to 120 grains of moisture, averaging 65 deg. with 45 grains of moisture, optimum 75 deg. with 50 grains of moisture.

Summer conditions in the south Temperate Zone range from 70 to 110 deg. with from 50 to 200 grains of moisture, averaging 80 deg. with 60 grains of moisture, optimum 75 deg. with 50 grains of moisture.

Conditions in the Torrid Zone range from 70 deg. to 120 deg. with from 60 to 300 grains of moisture, averaging 90 deg. with 100 grains of moisture, optimum 80 deg. with 60 grains of moisture.

It can readily be seen how very wide of the health and comfort mark natural weather conditions run, even in our most favored climates.

Heating under conditions that are otherwise too cold, or cooling under conditions that are otherwise too warm do not, in themselves, properly remedy the conditions. Warming a cold dry atmosphere reduces its relative humidity still further, thus causing discomfort and respiratory diseases. Cooling a hot moist atmosphere further increases its relative humidity, thus reducing its evaporative cooling capacity and causing it to feel oppressive and clammy to the body. The moisture content of the air must be properly adjusted, within limits, by adding moisture to the cold dry air as it is being heated or by removing moisture from the hot moist air as it is being cooled.

Effect of Weather Conditions Upon Industry

As to the effect of weather conditions upon industry and industrial processes, we have already noted how many products are fabricated at great distances from where the raw materials are grown, principally on account of atmospheric conditions. A far greater number of these and other products are manufactured under varying atmospheric conditions which are far from sanguinary as far as operations on an economic, continuous, regularly-scheduled quantity and quality production basis are concerned, except where air conditioning is properly applied to correct the indoor atmosphere conditions that would otherwise exist as a natural consequence of outside conditions instead of simple heating or cooling for regulating the temperature only.

For most products the moisture content and the temperature of the surrounding air must be adjusted and accurately controlled, the air must be properly distributed and be kept in circulation. For many the dust and dirt must be removed, for some objectionable gases must be carried away, and for still others excessive heat must be removed, otherwise such disconcerting and disadvantageous difficulties as the following may be encountered:

In textile mills the threads will become brittle or flabby, break or become tangled, no standard strength of fiber will obtain, the weight and count of the weave will vary, static electricity will cause fibers to fray and regularly-scheduled continuity of operations will be greatly handicapped due to variations in temperatures and humidities.

In the manufacture of rayon, closely controlled, but different, atmospheric conditions are a necessity for almost every process in the factory.

In candy factories the centers will sweat and become deformed, coatings will run and lose their gloss, cocoa butter will ooze through and white coat the outside, jellies will not form properly and many mixtures will not function, except under proper temperatures and moisture control of the surrounding air. Dust removal is also essential to the cleanliness and sanitation of the process. Such conditions are a hazardous gamble under natural atmospheric conditions for any modern plant that is expected to operate on any regular schedule regardless of outside weather conditions.

In tobacco manufacture, from the curing, stemming and assorting of the leaf to the finished cigar, cigarette, pipe tobacco or plug, there will be trouble with burning or moulding in curing, with wasteful crumbling and unbearable dustiness, disastrous interruption of machine operation in cigar or cigarette making, improper conditioning of the materials and deteriorative storage of the finished products if left to the mercy of natural atmospheric conditions.

Pharmaceutical products will vary in weight and size, capsules and pill coatings will not form and harden properly, dust and dirt will enter the preparations, the highest order of sanitary conditions will not obtain and certain powders will not compress properly into tablets under natural air conditions.

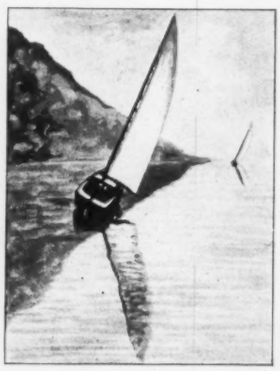
IT USUALLY RAINS WHEN WE DON'T WANT IT TO; PROPER HUMIDIFICATION IN THE WINTER TIME WOULD MEAN REDUCED ILLNESS AND INCREASED COMFORT. LUCKILY, IT CAN BE DONE INDOORS

In the printing and lithographing business, and especially in fine multicolor work, the expansion and contraction of the paper, the clogging of the inking rolls, the clinging of paper due to static electricity, the warping of paper board and other similar difficulties are all due to varying weather conditions.

Too Much Air Motion Is Dangerous; Here's What a Storm on Lake Michigan Did to Several Yachts in a Chicago Harbor

In the milling of grain the standard of quality cannot be properly maintained under ordinary weather variations.

In the leather industry hides cannot be stored, kept in proper working condition, finishing coatings cannot be properly applied, materials in work cannot be kept in case and finished products cannot be properly cured and stored in ordinary atmospheric conditions.

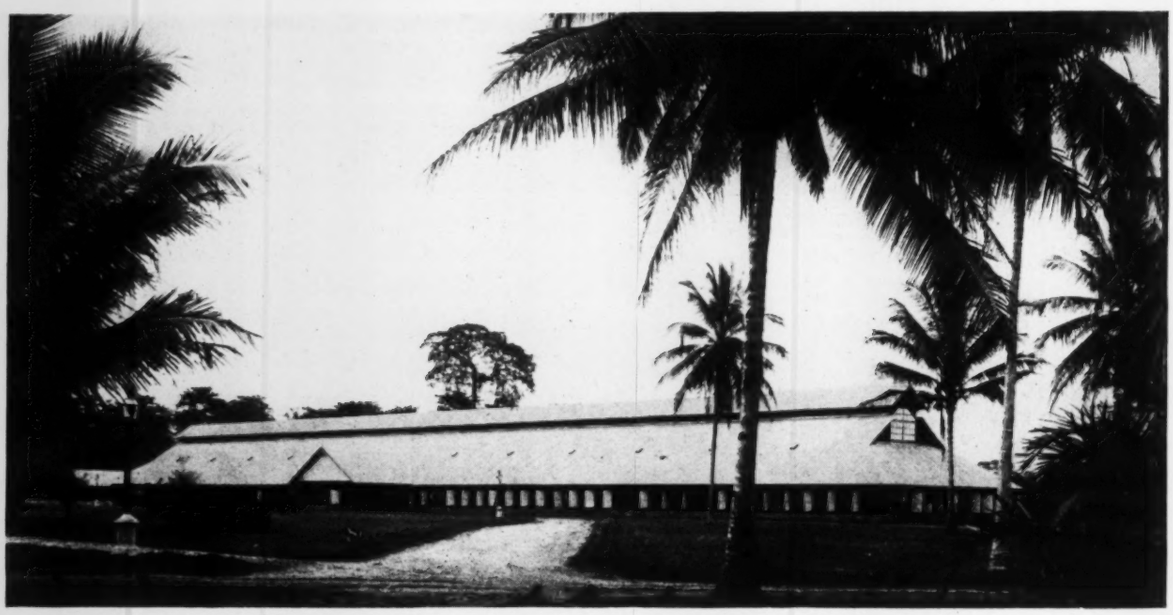


In picture film manufacture the hardening of film base and the drying of coatings as well as the elimination of very objectionable dust particles are all sources of major difficulties under natural weather conditions.

In the making of insulators and insulating materials and in the manufacture of fine electrical instruments, radio sets, wireless apparatus, fine marine, aeronautical, army and navy electrical instruments, uncontrolled weather conditions have a marked effect up to the point of where the weatherproof protections are applied.

In a great many chemical products the weather conditions have a great deal to do with the strength and chemical property of the compounds as with sulphuric acid and other reagents which are highly hygroscopic, taking up moisture in varying quantities from the surrounding air, depending upon its conditions as to temperature and moisture.

In all industrial plants where the materials are hygroscopic and thus absorb or lose moisture from or to the air, it is generally found that varying natural atmospheric conditions are sources of serious trouble, and in these as well as in others where the materials are not subject to difficult processing under natural conditions, we have the health, comfort and efficiency of the operatives, the effects upon whom are: enervation and reduced efficiency



A Modern Tobacco Barn in Sumatra, Well-Lighted, Perfectly Sanitary, and, Most Important of All, Properly Ventilated

TABLE 1—ATMOSPHERIC CONDITIONS REQUIRED FOR THE HEALTH AND COMFORT OF HUMAN BEINGS NORMALLY CLOTHED AND SLIGHTLY ACTIVE

AIR VELOCITY IN FEET PER MINUTE	FOR WINTER		FOR SUMMER	
	DRY BULB F	WET BULB F	DRY BULB F	WET BULB F
0	70	55	75	63
100	72	57	77	65
300	75	60	80	66

from overheating dry winter air, or the withering devitalizing effect of the excessively moist warm summer air, unless the moisture contents, air motion and temperatures are all properly adjusted and controlled.

In retail stores the overheated, enervating air in winter saps the vitality and "urge-to-buy," and the hot humid air of the summer drives the customers away to cooler and more pleasant surroundings, unless proper corrections are made in the indoor results from natural outdoor weather conditions.

In the manufacture of explosives and ammunition (especially fuses and standardized burning rate powders) the variation in the weather exerts a very detrimental influence.

In practically all drying processes, the accurate adjustment and control of humidities and temperatures are essential to the economy of the process and the quality of the product.

Some Physical Effects of the Weather

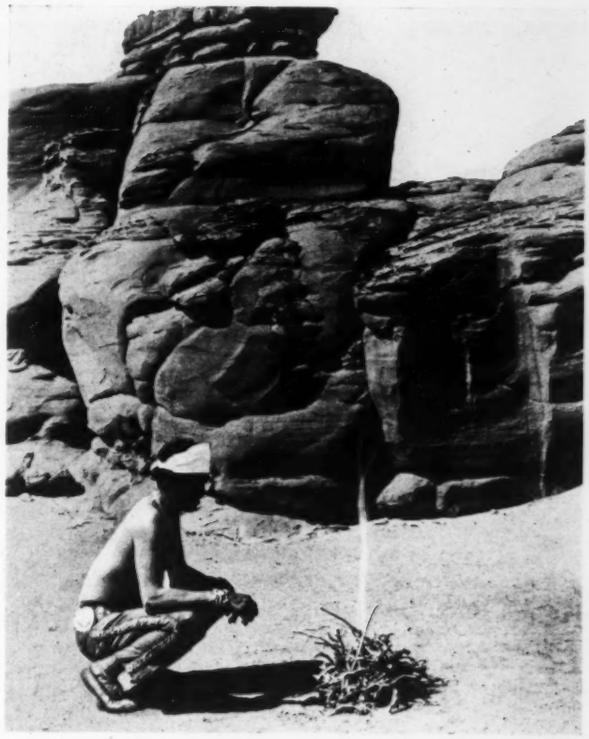
Although we are all familiar with the physical effects of the weather, it may be interesting to recall here a few of the more outstanding phenomena in order that we may better visualize what can be done by the weather in addition to the long category already enumerated.

It can freeze and stop the mighty torrents of a Niagara Falls, solidify one-fourth of the globe's salt water surface and send out into the waters of the temperate zone such a mountain of ice as to cause the wreck of a Titanic, snow bind the giant trains of our western railroads, cover the heads of great mountains with perpetual ice and snow, create glaciers to plow canyons throughout the length of the continents, loose torrents of water to collect and cause a Mississippi flood, demolish whole cities and provinces with a mighty tornado, wreck ships and water fronts with a storm at sea, cause death and destruction with an electric storm, bring untold suffering and death with excessive heat and humidity and produce many other tremendous results with which, as has been said, we are all familiar.

And yet, "What is so rare as a day in June," or, as for that matter, any other time when the temperature, the humidity, the air motion and the vital qualities of the air are just right?

What Can Be Done About the Weather

We have before us now a considerable story of what the weather can do, is doing, and from past experience will keep on doing, unless we do something about it.



AN INDIAN IN THE DESERT REDUCES THE RELATIVE HUMIDITY STILL FURTHER; WE DO THE SAME THING WHEN WE HEAT THE COLD, DRY AIR OF WINTER WITHOUT HUMIDIFICATION

Needless to say, there is little we should wish to attempt in reference to the weather out-of-doors, except to prepare for it, use proper protections and precautions.

TABLE 2—ATMOSPHERIC CONDITIONS REQUIRED FOR INDUSTRIAL PROCESSES

	DRY BULB F	WET BULB F
Textiles	75	65
Tobacco	70	60
Candy	68	55
Printing	68	56
Leather	70	60
Picture Films	70	55
Insulators	75	54
Ceramics	68	55
Pharmaceuticals	66	56
Chemicals	65	55
Milling	68	56
Explosives	70	60

Indoor weather is another matter, however, which depends entirely upon what we make of it.

The walls of our buildings and the conditioning of the atmosphere within make the difference between what we require for our health and comfort and for the proper

efficiency and efficacy of our manufacturing processes, and what we would otherwise experience.

The day in June can be enjoyed the year around at the North Pole or at the Equator.

Any product can be manufactured contiguous to the raw materials or other natural resources.

Continuous schedules with standard quantities and qualities of goods can be maintained.

Many improvements in processing and in the products of processes can be effected.

Many by-products and waste reclamation can be developed.

The efficiency, spirit and urge to accomplish of the workers can be improved.

The scale of life and its accomplishments can be elevated.

All of these can be accomplished in proportion to some function of the improvement in our indoor atmospheric conditions, depending uopn the exact requirements to be met, and the relative cost of meeting these as compared with the returns.

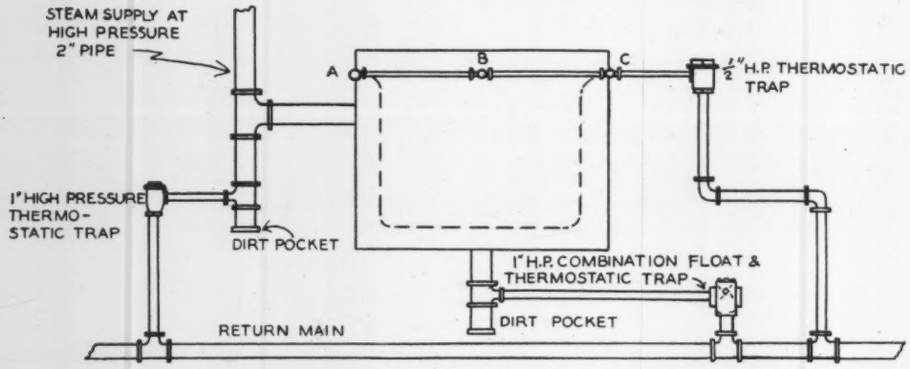
This sums up what we have been talking about in this series of articles and brings us to the end of the road of controlled indoor atmospheres.

Before closing, it is desired to say that there is one best condition of controlled indoor atmospheres and many better than those generally resulting from natural out-of-door atmospheres which are simply warmed or cooled and with which we are more or less generally familiar.

For those who are particularly interested in this most responsive field of improvement, two tables are presented, one of which (Table 1) shows the atmospheric conditions within the comfort zone for human beings normally clothed and moderately active and the other (Table 2) the atmospheric conditions best suited to a long list of industrial processes. (Of course, special conditions in a specific plant might vary these requirements.)

These tables are intended to further illustrate what can be done with the weather and to show the approximate conditions required for various purposes. Exact requirements must be determined for each individual case by a survey of the conditions, but after the requirements are once known it is a simple matter for those who know how to produce these conditions day in and day out without deviation from the conditions required or disappointment.

How to Pipe a Steam Kettle to Prevent Air-Binding



In Evaporators for Baking Powder, Bakelite, Etc., Air Binding Is Harmful. A Set-Up Such as This Will Eliminate Air Binding and Secure a High Rate of Evaporation

TIME and again the maintenance engineer in candy, bakelite and similar industries runs into air-binding trouble on steam jacketed kettles. This shows itself by the gradual cooling off of the upper part of the jacket, above the inlet of the steam supply pipe. This is probably not very harmful for regular cooking and heating process work but on evaporators for baking powder, bakelite, etc., it may become very costly.

The drawing shows how to pipe up such an evaporator to eliminate air-binding and secure a high rate of evaporation in the kettle. As most evaporators use high pressure steam, probably from 50 lb. per sq. in. upwards, a typical high pressure installation is shown.

At points *A, B,* and *C* the jacket is tapped at its very top and these tappings are connected up with each other through a ¼-in. pipe, finally running out into a ½-in. high pressure thermostatic trap. If there is very little pressure in the return main, the return side of this trap may be connected into this main, otherwise a blow-off connection to the outside of the building, or into a nearby sewer, will be necessary. To insure the discharge of all air carried along in the condensate, a high pressure combination float and thermostatic trap should be installed and if the unit is fed from the end of the steam main a drip trap should be installed as shown in order to give the evaporator maximum efficiency.

The openings *A, B* and *C* connected to the thermostatic trap will insure the jacket being free from air at any time and the trap will see to it that no steam escapes after the air has been forced out.

Another desirable feature about this hook-up is that in cases where such a jacketed kettle is equipped with temperature control, the thermostatic trap will hold the vacuum set up by the sudden shut off of the steam supply by letting air back into the jacket and, due to this fact, the sudden inlet of steam will not cause any hammering and will thus prevent breakage of the jacket or the kettle.—*E. M. Mittendorff.*

Piping Requirements for Vacuum Driers

By Malcolm C. W. Tomlinson*

MANY industrial plants have vacuum methods of drying. The heating system usually is installed in the form of pipe coils inside such a drier although other forms of radiators, such as electrical heating units, are often used. Most plant engineers are familiar with the best methods of figuring the insulation for such a drier. At the same time they are usually in the dark as to what happens so far as heat output of radiators is concerned, after the vacuum is turned on.

In 1920 John R. Allen, as director of the research laboratory of the A. S. H. V. E., published a paper on the radiant and convected heat output of cast iron radiators operating under conditions usual in house heating. The report included test data on the heat output of a cast iron radiator while in a vacuum. These test data are reproduced in Fig. 1. It will be seen that the information covered a rusty radiator, the same radiator coated with aluminum, and the same radiator coated with black paint. This information is of particular value and will be referred to again. It should be noted, in passing, that the steam temperature was 215 F and that the temperature inside the vacuum tank was approximately 60 F.

Equation for Radiant and Convected Heat

The equation for figuring the radiant and convected heat output of any radiator consists of two parts. It is based entirely upon the heat transmitted by radiation added to the heat transmitted by convection. It is written as follows:

$$Q = DR\left[\left(\frac{T_s}{100}\right)^4 - \left(\frac{T_r}{100}\right)^4\right] + K\,(t_s - t_r)$$

where

Q = Total Btu delivered per hr. per sq. ft. of rated surface of radiator
D = Radiant heat constant dependent upon radiator surface
R = Constant for ratio of radiating to rated surface
T_s = Absolute temperature of steam in F
T_r = Absolute temperature of air in drier F
K = Constant for convection
t_s = Temperature of steam in radiator in F
t_r = Temperature of air in drier in F

For clean cast iron radiators $D = 0.157$; $R = 0.28$ to 0.85; and $K = 1$.

Determination of Constants

The use of this formula is greatly restricted due to the fact that there is little information available on the constants R, D and K. The determination of these constants is, therefore, of considerable importance for each variation in shape, size, spacing and surface conditions of the radiators used. The problem consists of running a condensation test on an empty but insulated drier. In this test the steam pressures, steam temperatures, average drier temperatures and weight of the condensate are measured. The amount of moisture in the steam is determined by a steam calorimeter so that the calculations can be based on dry steam.

The results of such a test are shown in Fig. 2. Here the condensate, the steam pressures and the drier temperatures are plotted against the time. While the vacuum pumps were started at the end of the third hour the drier was exhausted only to two inches absolute in a quarter of an hour, after which the pressure within the drier was held constant.

It is interesting to note how great is the amount of steam condensed in the first half hour of the atmospheric period, how the condensate soon reaches a fairly uniform level and how, as the vacuum is applied, the condensate decreases to new low levels. It is also of interest to note the temporary but marked increase in the gage pressure of the steam after the vacuum is applied. This is a peculiar characteristic of vacuum drying and must be checked by adjusting the pressure, shortly after the vacuum is obtained, in order to prevent the temperature inside of the drier from rising above the desired level.

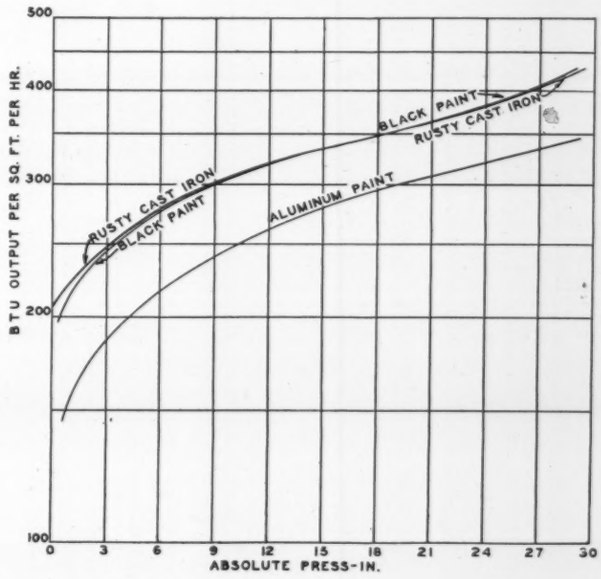


FIG. 1—HEAT LOSS FROM CAST IRON RADIATOR IN A VACUUM

* Consulting engineer, Philadelphia.

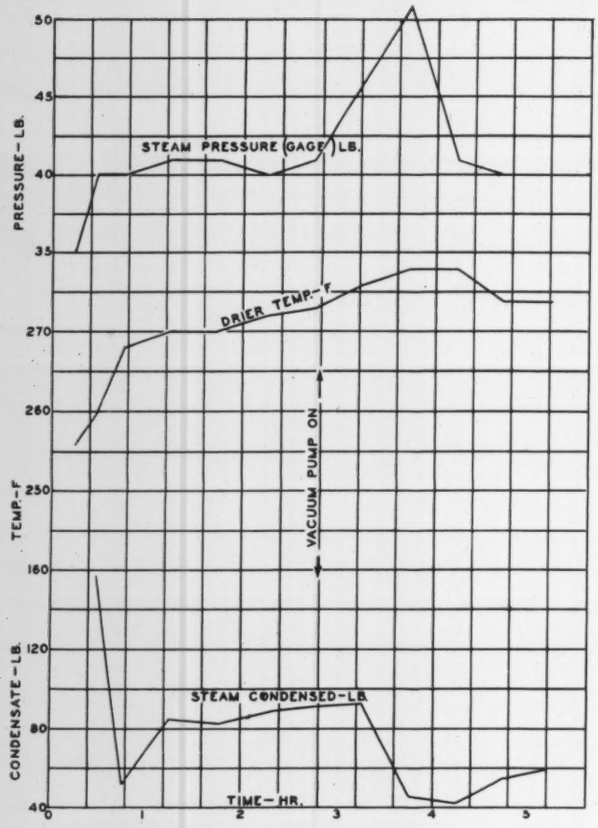


FIG. 2—VACUUM DRIER TEST DATA

Description of Drier

A brief description of the drier under test is pertinent. It was 40 ft. long, 7½ ft. in diameter and fairly well insulated. The radiator consisted of two pipe coils which looped back and forth from end to end of the drier. These coils were pitched sufficiently to afford drainage of condensate. They were made of two-inch steel pipe which showed no signs of rust but which had an oily surface. It is the pipe surface, as well as the method of installing the pipe coils, for which radiation constants must be secured. Outside of the pipe coils the drier was empty so that no materials or equipment which could be avoided affected the test results.

Analyzing the Data

In order to approach the problem in a satisfactory manner the test data are first divided into three separate groups: Those for the first hour under atmospheric pressure, those for the next two hours under the same pressure and those for the last two hours under a vacuum of 2 inches absolute. The averages for these periods, and the heat calculations, are given in Table 1.

In Fig. 1, it is interesting to note that the three surface conditions for the cast iron radiator tested gave practically the same result as far as decrease in heat loss is concerned for the various vacuum conditions. This may be seen readily in Fig. 3 where the percentage of heat output for a clean rusty surface and for a surface painted black or aluminum is shown. It is evident that an absolute pressure of two inches, or a vacuum of 28 inches, decreases the possible heat output of a cast iron radiator approximately one-half, irrespective of the condition of the surface of the radiator. It is probable that the heat output for any radiator in a vacuum of like amount will decrease the same amount. This decrease in heat delivered is altogether concerned with the convected heat part of the problem, as the radiant heat output remains at a fixed amount from a zero (absolute) vacuum up to and including atmospheric pressure conditions.

The Constant *DR*

With this information available it is now possible to figure the constant *DR*, as follows, from the data obtained under the vacuum conditions of the drier test. Here the convection of heat is reduced, as we learn from Fig. 3, by one-half. Therefore:

$$6.3 = DR\left[\left(\frac{289.5+460}{100}\right)^4\right]-\left[\left(\frac{276+460}{100}\right)^4\right]+\left(\frac{289.5-276}{2}\right)$$

Solving, we find that *DR* is equal to 0.0616 where *K* is equivalent to 1 and where the convected heat output is decreased a half on account of the vacuum carried. This result is within the range of the values determined by Allen for cast iron radiators. His values range from 0.044 to 0.134.

Checking this determination for *DR* by solving the remaining two equations for atmospheric conditions (where the convection constant *K* of 1 is not affected by a vacuum) the following results are obtained for the first test period:

$$18.4 = DR\left[\left(\frac{284.7+460}{100}\right)^4\right]-\left[\left(\frac{261.3+460}{100}\right)^4\right]+\left(\frac{284.7-261.3}{1}\right)$$

or *DR* equals 0.1115

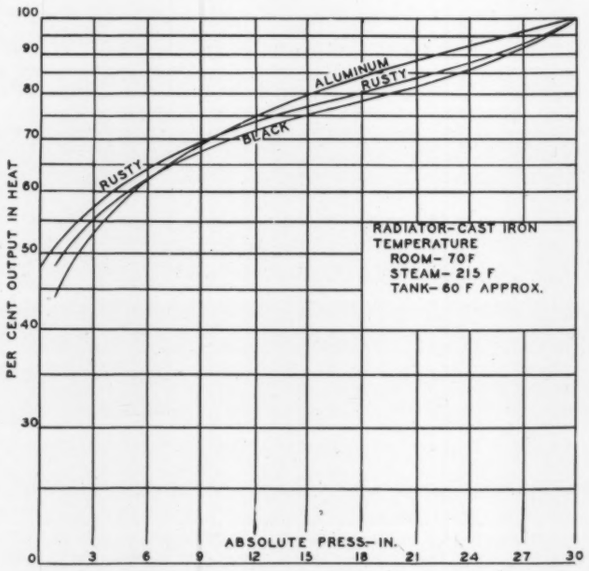


FIG. 3—PER CENT RADIATOR OUTPUT IN A VACUUM

TABLE 1—AVERAGES FROM DRIER TEST

Condition in drier	1ST HR. atmospheric	2ND & 3RD HR. atmospheric	4TH & 5TH HR. vacuum—2 ins. abs.
Avg. drier temp. in F	261.3	271.2	276.0
Avg. steam press.—lb. per sq. in	38.3	40.75	43.25
Avg. steam condensed—lb. per hr	295.0	178.0	102.0
Avg. steam temp. in F	284.7	281.6	289.5
Total Btu output of radiator per hr	272345	164720	93750
Btu per sq. ft. pipe surface	18.4	11.1	6.3

For the second test period:

$$11.1 = DR\left[\left(\frac{281.6+460}{100}\right)^4\right]-\left[\left(\frac{271.2+460}{100}\right)^4\right]+\left(\frac{281.6-271.2}{1}\right)$$

or DR equals 0.1272

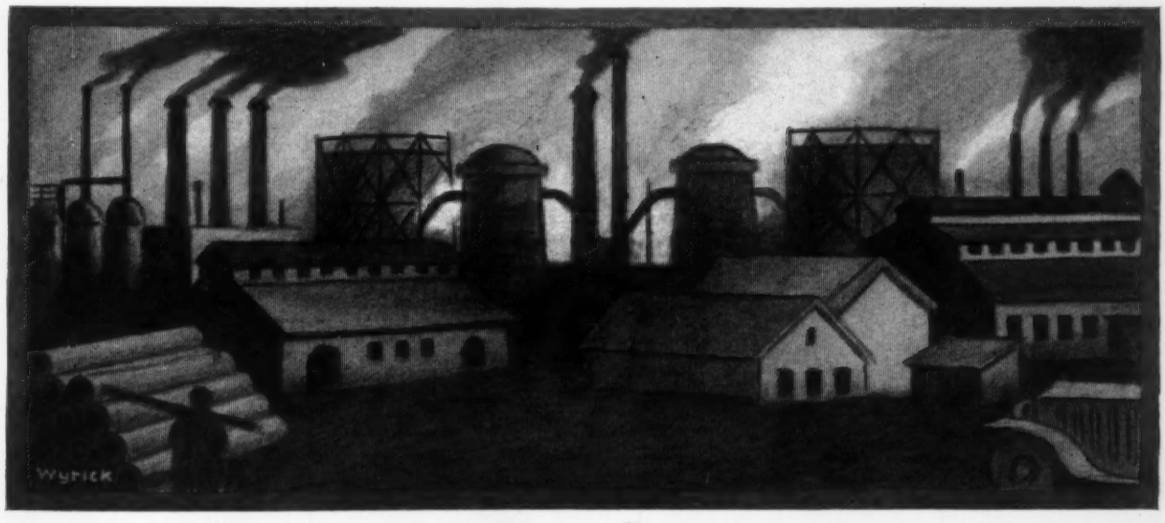
It now remains to determine, if possible, why DR has varied so markedly under atmospheric and vacuum conditions. It is evident, in the first place, that the result obtained for DR under a vacuum is within the range of test data and appears consistent. Since R is a shape factor it seems evident that it could not have changed. Therefore D, which is dependent on surface solely, is the only factor of the two which could have changed under the test conditions. With atmospheric pressure the oil on the pipe coils would have dried or vaporized and the relative humidity would have markedly decreased. As the vacuum period came on, the air, with its moisture and oil vapor, would have decreased rapidly. It is therefore posible that D would have changed gradually, during the atmospheric period, towards an increased heat output. There is no apparent reason for the marked decrease, between the atmospheric and vacuum periods, of the factor DR. It therefore seems evident not only that the values for DR as calculated for the atmospheric periods should have been lower but also that an error was made in recording too much condensation for the atmospheric periods. While the values obtained are not comparable with what could be expected, at the same time the test data has made possible a clear picture of how heating calculations for vacuum driers should be made.

Figuring Piping Requirements

The mechanics of figuring the piping requirements are now obvious. The first step is to obtain satisfactory data on the constant DR. This may require tests, such as have been outlined, in case variations in surfaces and in other conditions are likely to set up a situation not covered by available data on D or R. The next step is to use the equations furnished to obtain information as to the total number of British thermal units which can be expected if a definite steam pressure (which, of course, determines the steam temperature) and drier temperature is employed.

In this connection it may be well to point out that, if available, exhaust steam is very efficient in supplying heat. The corresponding temperature for any steam pressure can be secured, of course, from steam tables. Where the material to be dried is to be changed or new materials are to be used it will be necessary to determine the amount of heat which these materials will take up or absorb. This heat is, of course, a loss so far as the drying of the materials is concerned. It also may be necessary to figure the heat absorbed by the trucks or trays which hold the materials in the vacuum drier.

Once the total amount of heat required per hour is determined in Btu this quantity is divided by the latent heat of vaporization, which corresponds to the steam temperature, to obtain the pounds of steam which must be furnished. This calculation should be made for the heating up or atmospheric period and also for the vacuum period as it is evident, from the calculations furnished, that the steam requirements will fall off when the vacuum is applied. When this calculation is made it will be seen why low pressure steam is efficient. Steam at 193 F corresponds to 4.7 lb. back pressure, or 9.5 inches of mercury vacuum, and has a latent heat of 983 Btu per lb. If the steam pressure were 100 lb. gage pressure the steam temperature would be 338 F and the latent heat of steam would only be 882 Btu. Therefore, the latter pressure would require that $\frac{983}{882}$ or 1.11 times as much steam would be necessary to secure the same evaporation.



When the quantity of steam required has been figured, the pipe requirements can be calculated by means of various tables or equations. The following equation is suitable:

$$W = 5220 \sqrt{\frac{P D d^5}{\left(1 + \frac{3.6}{d}\right) L}}$$

where P = loss in pressure in lb.
d = inside diameter of pipe in inches.
L = length of pipe in feet.
D = weight of 1 cubic foot of steam in lb.
W = lb. of steam per hour.

Dust in Schools

"The heavier, less dangerous dusts carried in school room atmospheres fall rapidly to the ground, but the lighter, breath-infected dusts hang about for as long as half an hour," states Professor Hagemann, of Essen, Germany, in his report on minimal hygienic requirements of the schoolroom. Dust is brought into the schoolroom chiefly on the children's shoes, he says. To keep it out of the air, Professor Hagemann recommends that seats be adjustable as to height and that footrests in the form of grating be installed through which street dust will fall to the floor. The grating will prevent continual scuffing up of dust into the air. Such an arrangement would be useful for drying the shoes in wet weather also, he says.—*S. P. M.*

"Open for Discussion"

A department in which we follow the custom of technical societies in allotting space in their programs for discussion of the papers presented

Reducing Operating Costs

"Elimination of Waste Campaign." Page 625, July, 1930, issue

COMMENTING on your editorial on p. 625 of your July issue, I like to think of the elimination of waste as conservation of natural resources.

HEATING, PIPING AND AIR CONDITIONING, the magazine, stands for conservation especially in the three departments mentioned in its title.

In heating we have achieved the state where no one who expects to heat his home with gas or oil as fuel fails to require building-insulation against undue heat loss. No one fails to provide automatic temperature regulation where expensive fuels are used.

Use of Electric Heating

We still, however, allow much of the great electric generating capacity of the nation necessary for a few hours peak or emergency load, to stand idle during many hours each day. One can predict that electric heating of houses, with its low transmission-line losses and its high efficiency and easy measurement and control, soon will be reducing the hours of idleness of the generating plants.

If we carry building-insulation far enough and if we assume a broad gauge attitude in the control of our great power stations, it is the belief of the writer that electricity will become a more general method of house heating.

Combination conventional heating systems arbitrarily designed to serve up to the average cold weather, with auxiliary electric heating to carry over the very few exceedingly cold days already are in use, and these have reduced the investment cost sharply.

Economy in Piping

In piping, greater attention constantly is being paid to the proper sizes. Research is being carried on to develop the frictional resistance of piping. An intelligent basis of design for any piping system would, it seems, be easy, if one knew enough about the friction and if one could control the workmanship.

Possibly such a design-basis would always assume a given pressure-drop for the longest run, and would then establish the sizes of all the shorter runs of piping proportional to the longest run to achieve the same pressure-drop. (Editor's note: See the article "Economical Steam Pipe Sizes," by A. W. Moulder, elsewhere in this issue.)

Refinement in the use of cu[illegible] of tools and in the design of pipe fittings to eliminate [illegible]ed veins and turbulence, it is believed will permit [illegible] sizes.

Installing Ventilating Ducts

Ventilating ducts made to order to dodge around beams and pipes and conduits are exceedingly costly and usually are inefficient as to friction losses.

The cost situation is aggravated for ducts because of the high proportion of the labor cost to the material cost.

The adoption of a system of duct-proportioning along the lines suggested above for pipe runs would make surprising reductions in the shorter ducts on every installation.

A wiser evaluation of the right of way in building construction would offset great savings, letting the ducts have a better break by doing more blending of the other construction materials to avoid them.

Air conditioning requires building-insulation and automatic control, and clean-cut pipes and ducts. This department draws upon all of the others as far as its physical elements apply.

The great savings to be apprehended here lie along lines of maintenance and operation.

A One-Fan Job

I found recently two exhaust fans pulling from one vent chamber and discharging through the same outlet

shaft. One of these fans went out of service due to failure to provide lubrication. The other, running along, performed no useful work, as its discharged air passed backward through the quiescent fan to supply the suction-demand, and the air was delivered around and around, and the building was un-ventilated. This one-fan job had been operated for years in the attic of the office building of a corporation of national importance.

Too often we find fine air conditioning equipment condemned and shut down simply because the designer knew no better than to expect spent warm air from the building to go outdoors through a horizontally looking outlet in the face of a heavy wind.

In most industrial plants the organization is so impressed with *production* that maintenance or operation of the ventilating equipment is neglected.

Any jack of trades can design a heating system or a piping system and can get away with it if he makes everything too big. There is plenty of room for the careful designer who always makes things just about big enough. The latter engineer is the one who conserves natural resources and who is in the shock line in the elimination of waste campaign.—*Samuel R. Lewis.*

Quartz Windows for Buildings

"Whither Air Conditioning?" *by Esten Bolling.* Page 281, April, 1930

WE HAVE read with much interest the splendid article by Esten Bolling in the April issue of HEATING, PIPING AND AIR CONDITIONING, and might commend the various points made, but just "yessing" is superfluous.

I wish to enter my protest, however, against the author's agreement with Dr. Luckiesh in his unconsciously selfish opinion (or propaganda) against windows. Why should we expect to develop artificial sunlight for interiors when it is reasonable for quartz windows to be the thing of the future and also in view of the fact that the walls of many buildings now consist of approximately 10 per cent to 25 per cent masonry and 75 per cent to 90 per cent light metal and glass? The elimination of smoke and dust from the atmosphere is a necessity, not merely for the sake of light, but also for the sake of the health of persons who have to be outside properly air conditioned buildings.

I cannot make this comment without saying further that the general composition of the article is as usual most delightful.—*S. H. Harper,* District Engineer, Aerofin Corporation.

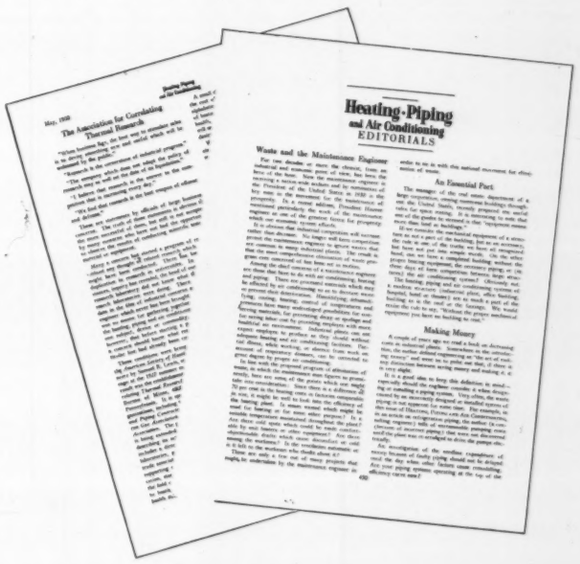
Correlating Research

"The Association for Correlating Thermal Research." Page 451, May, 1930

I READ your editorial in the May issue on the *Association for Correlating Thermal Research* with a great deal of interest, and am convinced that the editorial is timely and to the point. The elimination of waste is demanded more and more each year, and to no one should waste be more abhorrent than to the engineer. Waste is the enemy of efficiency, and an engineer is he who can accomplish most with the least expenditure, whether that expenditure be time, money or effort.

Research is the vehicle upon which our industries must ride to greater things. Without research, progress would become a groove out of which we could not turn; but research uncorrelated must result in waste, for then any number of organizations will be duplicating each other's work on the same problem.

It is true that a considerable amount of research work will always be carried on by large corporations in connection with industrial or manufacturing processes of a trade-secret nature as one manufacturer may hope to


Heating·Piping and Air Conditioning
EDITORIALS

derive some benefit for his organization over a competitor through discoveries he may make in his own laboratories. Nevertheless, there are many research problems of a general nature upon which research has been, and doubtless is at present, carried out where duplications exist and the waste in time and effort might be eliminated through co-operation with the *Association for Correlating Thermal Research.—John Howatt,* Chief Operating Engineer, Board of Education, Chicago.

Church Heating

"Heating and Ventilating Churches," *by Samuel R. Lewis,* Page 552, July, 1930 issue

"HEATING and Ventilating Churches" contains many suggestions which will bear elaboration. I cannot agree with the author on all of his suggestions and statements, but I believe it would be particularly advisable to emphasize the suggestion he makes regarding the time required to heat a church or any other cold building. It requires capacity which is not often furnished. There are many more churches which require five, six or ten hours to heat from a cold condition, than can be heated in one or two hours, as Mr. Lewis suggested.

Mr. Lewis's article is valuable in pointing out to the heating contractor who has not had much church experience, that it is a different problem than that provided by almost any other class of building, and such suggestions made through your columns cannot help but have value.—*E. K. Campbell,* E. K. Campbell Heating Co.

Humidity a Factor to Consider *in* Storage of Food Products

By Herman Vetter*

This article points out the importance of air conditioning and its control in the matter of food storage. It is obvious that to maintain the proportion of moisture in food, fruits, etc., in relation to solids, loss by evaporation must be avoided. Since any evaporation would be transferred to surrounding air, it is important to maintain a vapor pressure balance or equilibrium.

As water flows from a higher to a lower level, so also does moisture transfer take place according to vapor pressure differences. It is important not only to provide a temperature that will prevent a rapid breakdown of the physical structure but also to maintain a dew-point temperature of the surrounding air, depending upon the vapor pressure desired to avoid shrinkage loss.—E. P. Heckel.

TO SHOW the importance of humidity in connection with refrigeration in preserving food products, Table 1 lists the characteristics of some of the common varieties of foods.

Examining this table it will be noted that all food products are composed of a larger proportion of liquids than solids. In order to maintain the initial qualities of foods, it is important that we maintain their initial proportions of liquids and solids. It follows that the question of humidity cannot be neglected in our calculations.

Up to the present time, sufficient investigations have not been made to determine the proper humidity for each product. For general purposes, or until definite data are available, it is quite safe to maintain, at least, the same percentage of humidity as the product contains moisture.

Of all food products there is none more difficult to handle than bananas, and the effect of humidity has been more closely observed on bananas than on any other product. The most suitable air conditions for retarding the ripening of bananas is 60 degrees temperature and 80 per cent humidity. It will be observed that the humidity is five per cent higher than the moisture content of bananas.

For large plants it is desirable to provide humidifying apparatus as the additional cost would not be prohibitive. For small plants, or where the equipment is only used for short seasons, it is possible to obtain proper humidity conditions without special apparatus. Under ordinary conditions refrigeration causes a dehumidifying effect; therefore, unless we are careful in our design, we are very likely to have low humidity or dry air.

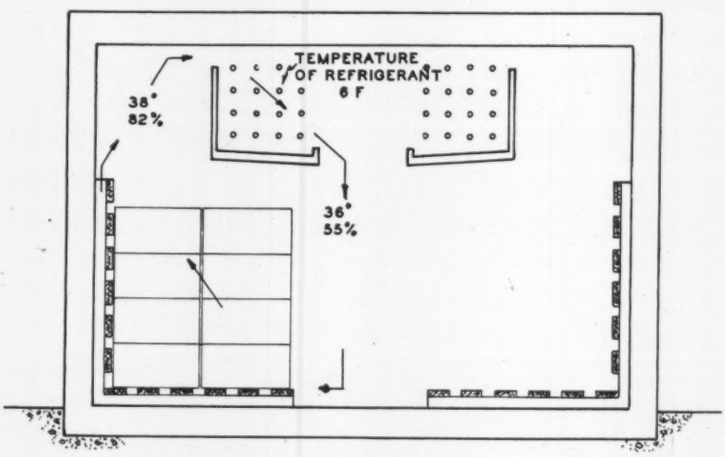


FIG. 1—A TYPICAL REFRIGERATOR WITH OVERHEAD BUNKER COILS. TEMPERATURES AND RELATIVE HUMIDITIES OF THE AIR ENTERING AND LEAVING THE COIL COMPARTMENT AND IN THE MIDST OF THE FOOD PRODUCTS ARE INDICATED

TABLE 1—PERCENTAGE OF LIQUIDS AND SOLIDS IN COMMON FOODS AND THE HUMIDITY AT WHICH THEY SHOULD BE STORED

NAME	TEMPERATURE F	COMPOSITION—%		RELATIVE HUMIDITY %
		WATER	SOLIDS	
Apples—(Storage)	32 to 36	63.5	36.5	.....
Bananas—(Retarding)	60	75.5	24.5	80
Bananas—(Ripening)	64	75.5	24.5	84
Bananas—(Forcing)	68	75.5	24.5	88
Lemons—(Storage)	36 to 38	.....	.....	85
Beef—(Storage)	34 to 38	68	32	76
Poultry—(Storage)	28 to 30	73.7	26.3	.....
Potatoes—(Storage)	36 to 40	74	26	.....
Eggs—(Storage)	31	70	30	.....

A Typical Case with Low Humidity

By referring to Fig. 1, which shows a typical refrigerator with overhead bunker coils, the direction of the natural air flow is shown; the temperature and the relative humidity of the air entering the coil compartment, that leaving the coil compartment and the air in the midst of the food products have been indicated. The temperatures and conditions shown were taken from a refrigerator operating under normal conditions.

*Chief engineer, Baker Ice Machine Co.

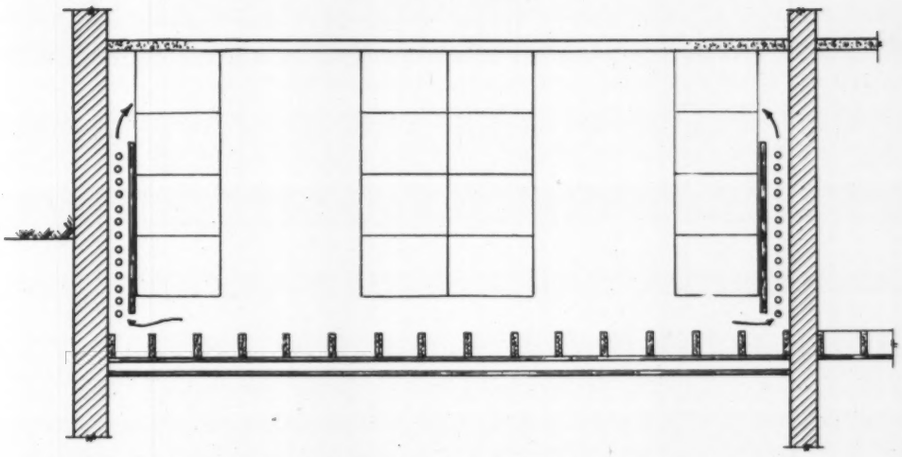


FIG. 2—SECTION OF A STORAGE ROOM WHEREIN PROPER HUMIDITIES ARE MAINTAINED. BECAUSE OF LOW HEAD-ROOM, THE COILS WERE PLACED ON THE WALLS

The temperature of the air entering the coil compartment was 38 degrees with a relative humidity of 82 per cent, the air leaving the coil compartment was 36 degrees with 55 per cent relative humidity. The air, in passing over the coil, lost 0.85 grains of moisture per pound of air circulated. Some of the moisture deposited on the coils was taken from the warm air entering the door openings but the greater portion was extracted from the products stored in the room. This loss is known as shrinkage and, as it sometimes runs as high as three per cent, it constitutes a vital item in the profits on the goods handled. In addition to the loss in weight there is also a loss due to excess trimming of the outside parts which have lost their natural fresh appearances due to dehydration.

An Installation with Proper Humidity

Fig. 2 shows a refrigerator in which the humidity was kept above ninety per cent, which prevented any moisture from being withdrawn from the products.

The room shown is 50 ft. long x 20 ft. wide x 8 ft. high. There wasn't enough head room for locating the cooling coils overhead, so the coils were placed on the walls.

The specifications called for maintaining a temperature of 36 to 38 degrees with a minimum relative humidity of 64 per cent. The products to be stored were budded plants and were to be kept in a dormant state. The roots of the plants were wrapped with moss and had to be kept damp, therefore the question of humidity was very important in order to prevent the roots from drying out.

The theory of humidity control as used in the above installation was based on maintaining the air adjacent to the coils at a temperature near the dew point corresponding to the relative humidity desired. Our problem would have been simple if we knew how much air would be circulated in a given time but as we had to depend on circulation created by thermo-syphon effect we could only approximate the rate of circulation. It is possible to compute the circulation but as there are factors which would upset our calculations, such as improper storing of goods, etc., an approximation is all that is necessary (especially as the results can be corrected, as will be explained later in this article).

For our calculations we assumed that twenty-five per cent of the air would be circulated over the cooling coils and this air, when mixed with the rest of the air in the room, would give the desired humidity. Theoretically, this would be our solution; however, when depending on natural or thermo-syphon circulation we cannot use this method, as the air leaving the coils is not mixed with the humid air until it is near the products. Therefore, the cooled air being super dry would dry out the products directly in the line of the air flow, and, hence, the air leaving the coils must be as near the desired condition as is possible.

The installation under discussion was designed to have the air enter the room at or near sixty-six per cent humidity and leave the room at about eighty-five per cent humidity. The cooling coil surface was based on an evaporator pressure of 35 lb., which corresponds to twenty-one degree ammonia temperature.

During the test the following conditions were obtained:

Evaporator pressure	35 lb.
Evaporator temperature	21 degrees
Air entering coil compartment	38 degrees dry bulb
Air entering coil compartment	37 degrees wet bulb
Relative humidity in midst of product	91 per cent

Correcting the Humidity Obtained

It will be noted that the humidity obtained was six per cent higher than that calculated. This difference can be corrected by gradually reducing the evaporator pressure until the proper humidity is obtained. In the plant in question this correction was not made, as it proved that the extra amount of humidity did not affect the product.

In the handling of food products it has been found that too little humidity is more harmful than too much humidity; therefore, the cooling coil surface should be based to give a higher humidity than desired and making the corrections during the test by reducing the evaporator pressure until the desired results are obtained.

The method used for maintaining the humidity as illustrated in the last example can be successfully used on any ordinary size of storage plant. For large in-

stallations, the central station spray type system (in which the air is cooled and conditioned in a central cooling plant) would be satisfactory. In the spray system, the air being circulated by forced draft the humidity can be more closely controlled. In this type of system high air velocities must be avoided, otherwise the products in direct line of the air currents will be subject to a drying effect.

Temperature, Humidity, and Air Motion Affect Apples in Storage

By Clarence E. Baker*

THE temperature at which apples are stored probably is the most important *single* factor and has received the greatest amount of attention from investigators of storage problems. The rate of softening of apples in storage is considered to be dependent to a great extent upon the temperature prevailing. The optimum storage temperature in general is considered to be 31 to 33 F. There are some apparent exceptions to this rule in the case of one or two varieties, but as a commercial practice these temperatures likely are entirely satisfactory.

As the temperature rises the activity of the fruit speeds up markedly. It has been found that it requires about 25 per cent longer for apples held at 30 F to reach the same degree of softness, as determined by the mechanical pressure tester, as fruit stored at 32. At 40 deg. the apples soften fully twice as fast as at 32 deg., and at 50 deg. the fruit softens nearly twice as rapidly as at 40 deg. At 70 deg. the rate of softening is again doubled over that stored at 50 deg.

Investigations also show a wide variation in the rate of softening for different varieties when held at the same temperature. *Rome, Stayman, Ben Davis* and *King David* reach a prime eating condition earlier than *Winesap, Arkansas, Yellow Newtown, York Imperial* and *Arkansas Black* when stored at 32, while *Grimes* and *McIntosh* and *Jonathan* reach the same condition much earlier still.

Humidity Control Essential

Next in importance to temperature is satisfactory relative humidity. The optimum relative humidity for apples at storage temperatures of 31 to 33 F is about 80 to 85 per cent. If the relative humidity is permitted to drop much below this figure for extended periods, water will be removed from the fruit to satisfy the moisture requirements of the air and the fruit shrivels and loses weight. The total amount of moisture in the air at this temperature is small, but nevertheless it is not an easy matter to maintain the required relative humidity. In large rooms where several carloads of apples are being stored, the humidity problem is not likely to be so great as with smaller rooms that have a greater ratio of wall area to the volume of stored produce.

Ordinary artificial means of increasing the relative humidity of the air have not met with general success although under some conditions it is possible to increase the humidity by the exposure of large free moisture surfaces such as blankets saturated with water or a weak brine solution. When these are used in connection with circulating air they are undoubtedly much more effective.

The sprinkling of the fruit or soaking of floors is sometimes resorted to, but are of doubtful value. The former generally leads to damaged or unsightly packages and the latter to disagreeable working conditions or insulation failures.

Alternate defrosting of the refrigerating coils, the introduction of steam and the bringing in of outside air all probably have some value in raising the relative humidity under the proper conditions, but each method has serious disadvantages and can not be depended upon to give accurate results.

* Purdue University Agricultural Experiment Station.

FIG. 1—THESE GRIMES APPLES WERE REMOVED FROM COLD STORAGE ON JANUARY 3 AND PHOTOGRAPHED SIX DAYS LATER. THE FRUIT IN THE BASKET ON THE RIGHT HAS BEEN PROTECTED FROM SCALD BY USING SHREDDED OILED PAPER. THOSE ON THE LEFT ARE TYPICAL OF UNPROTECTED FRUIT

The report of the relative humidity experimental committee of the cold storage division of the *American Warehousemen's Association* does not hold forth much hope of successfully controlling the relative humidity by any methods similar to those outlined above. In localities along the seaboard, they find that an average relative humidity of 83 to 85 per cent may be obtained by the admission of outside air, but in most inland localities the variation thus obtained was too great to be dependable. They suggest the intermittent defrosting of coils, permitting the slow evaporation of the frost coatings, and the judicious use of wet sacks hung in a current of circulating air as being the most successful make-shift methods of raising the humidity.

FIG. 2—THE INTERIOR OF AN APPLE ROOM IN A LARGE COMMERCIAL STORAGE. AIR CONDITIONING OF SUCH ROOMS AIDS GREATLY IN MAINTAINING HIGH QUALITY IN THE STORED PRODUCE

Special Equipment Necessary

Modern storage plants equipped with air conditioning systems or splash brine refrigerating systems appear to be able to maintain satisfactory humidity conditions. It is very desirable to have both the temperature and humidity factors under control, as only by so doing can optimum conditions for the intelligent storage of apples be provided.

Circulation of Air

Circulation of air is undoubtedly of value in apple storage rooms. Apples give off large amounts of carbon dioxide and volatile organic compounds. Concentrations of carbon dioxide as low as 5 per cent have been found to retard the normal respiration of apples in storage. Under some conditions this is not an undesirable feature while under other conditions it may be. In any case the flavor of fruit held in considerable concentrations of carbon dioxide generally is decidedly inferior to that of fruit stored in normal air. If the air of the storage room becomes too heavily loaded with carbon dioxide, ventilation then is necessary to remove the accumulation of the gas. If the relative humidity is low, the circulation of air is likely to cause greater shriveling of the fruit as the air immediately surrounding the fruit is more likely to be kept in motion.

Prevention of Storage Scald

The accumulation of the organic esters and similar by-products of respiration generally is held responsible for producing the most prevalent of all storage troubles with apples—storage scald. This is a physiological disease apparently caused by a killing of the skin cells of the apple following an accumulation of these volatile by-products of respiration about the fruit. Everyone who has had experience in handling apples in cold storage is familiar with the brown, dead skin often occurring on many varieties in storage during late winter. Frequently the diseased condition does not appear at all in storage but soon after the apples have been removed to a warmer temperature the skin of the fruit turns brown and unsightly.

Thorough ventilation helps to prevent this disease if it is possible to change the air immediately surrounding the fruit. This is almost impossible where the apples are stored in boxes or barrels, as the packages are practically air tight.

Fortunately there is a dependable control for storage scald in the form of the oiled wrapper. Ordinary paper wraps containing 16 to 20 per cent by weight of an odorless and tasteless mineral oil have been found to afford almost complete prevention of storage scald.

Fruit packed in baskets and barrels may be given protection by packing in shredded oiled paper, using it at the rate of one-half pound per basket or one and one-half pounds per barrel, thoroughly distributed among the apples in the package.

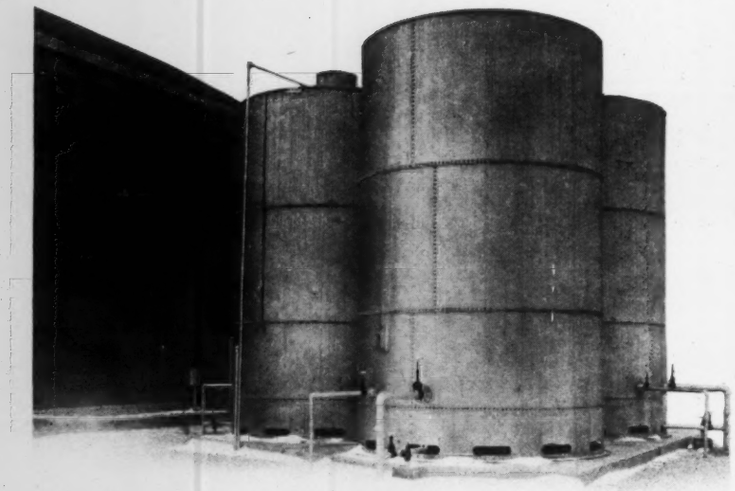
It should be needless to add that all traces of refrigerants must be excluded from apple-storage rooms. Apples suffer serious injury from small amounts of such compounds and any injury generally is held to be the fault of the storage company.

Occasionally quantities of apples are stored in rooms containing disagreeable odors that are absorbed by the fruit. Efficient air conditioning does much to eliminate this form of waste, providing the various storage articles are properly segregated.

Any system of air conditioning for apple storage rooms should provide for the circulation of large quantities of air, preferably fresh, through the storage compartments under an accurately-controlled temperature and with a predetermined relative humidity. Guess-work should be eliminated wherever possible and humidity conditions checked frequently with a sling psychrometer. If wilting is a serious problem proper air conditioning will do much to overcome the difficulty. Careful attention to these details will help to remedy the troubles frequently encountered in the storage of apples over a long period of time.

The Design and Installation

By A. H. Beiler*



ONE OF THESE TANKS HOLDS DIRTY OIL REMOVED FROM THE APPARATUS, AND THE OTHER TWO ARE USED FOR STORING CLEAN TRANSFORMER AND CLEAN SWITCH OIL

GROWTH of electric power systems within the last few years has been so rapid that it has given prominence to many problems which were considered relatively unimportant when the systems were smaller. One of these is the subject of insulating oil purification. Large quantities of insulating oil are stored in transformers and oil circuit breakers; in a fair-sized high voltage substation this may reach several hundred thousand gallons. The reliable functioning of this equipment is in a large measure determined by the insulating qualities of the oil. Its dielectric strength must be kept above the danger limit and frequent observations made to assure immediate precautions being taken if it falls below this value.

Loss of Dielectric Strength

Operation of oil circuit breakers causes minute carbon particles to be formed in the oil due to the destructive action of the electric arc formed during the opening operation. These particles decrease the dielectric strength of the oil. In addition, the breathing of the apparatus results in an accumulation of moisture in the bottom of the breaker or transformer tank. The oil has a tendency to dissolve some of the moisture in the air and subsequently precipitate it, forming an emulsion having a relatively low dielectric strength. This problem of breathing is not so important with conservator type transformers, but it is not infrequent that several quarts of water can be removed from the bottom of an oil circuit breaker tank after only a few months of operation.

Purification Apparatus

The apparatus to purify the oil thus becomes an important auxiliary for the successful operation of the electrical equipment. It is only in the last few years that central station companies have given much thought to oil purification machinery. Previously, a portable purifier of relatively small capacity was used which was moved to any station where the dielectric test indicated that a transformer or circuit breaker required its oil to be purified. The size of the stations soon warranted permanent outfits at the larger ones. The capacity of the purifier grew, permanent piping was installed between the apparatus and the purifier plant, and the elaboration of the process has made it advisable to build a separate oil house for all the apparatus used in connection with purification. The purpose of this article is to outline some of the design factors of such an oil handling installation based upon practice now standard with the American Gas and Electric Company.

When Is Installation Warranted?

The decision has first to be made as to whether a permanent installation is warranted for the particular station under consideration. This depends upon the importance of the station, the quantity of oil stored in the apparatus and whether or not another station having oil handling facilities is nearby. Where more than 10,000 gallons of oil are contained in the transformers and oil circuit breakers, a permanent installation is generally warranted. For more than 25,000 gallons of oil, a permanent installation is definitely indicated. The equipment can be divided roughly into three parts, the piping between the apparatus and the oil house, the oil storage system, and the oil house.

Oil Piping

The piping between the apparatus and the oil house is preferably buried several feet under ground. This makes a much sightlier layout, although somewhat more expensive than running the pipes on the surface. Galvanized steel pipe is used for this purpose.

There are two systems of pipes connecting to the apparatus, the clean and the dirty oil lines. These may in turn be sub-divided into transformer and switch oil lines.

The properties of two oils which can be considered

*American Gas and Electric Company.

# of Insulating Oil Piping *for* Electrical Substations

This article will prove of value to engineers connected with power companies and industrial firms having their own electrical substations. The problem of oil handling in connection with electrical stations is a relatively new one, and there is almost no data available. The author presents essential information difficult to obtain from other sources.

"universal" for either transformers or outdoor oil circuit breakers, provided the oil is new, are listed in the last two columns of Table 1. Used switch oil, even when purified, must under no circumstances be mixed with transformer oil for use in a transformer as it is practically impossible to completely eliminate the minute particles of colloidal carbon in such oil. These carbon particles would soon cause sludging if the oil were used in a transformer.

The best practice therefore is to use four pipes—for clean and dirty transformer oil and for clean and dirty switch oil. Sometimes, for economy, only two pipes are used—a single clean and a single dirty oil line. Of course, the two classes of oil are never run through the pipe simultaneously. The justification of this practice is the fact that the small amount of switch oil present in the line after emptying or filling an oil circuit breaker tank will only very slightly contaminate any transformer oil subsequently passing through the pipe.

TABLE 1—PROPERTIES OF THREE OILS USED IN TRANSFORMERS AND CIRCUIT-BREAKERS

	A	B	C
Flash Point, C	155	133	132
Burning Point, C	170	148	149
Pour Point, C	-40	-40	-40
Viscosity at 37.8 C	90 seconds	55	57
Specific Gravity at 15.5 C	0.821	0.838	0.898

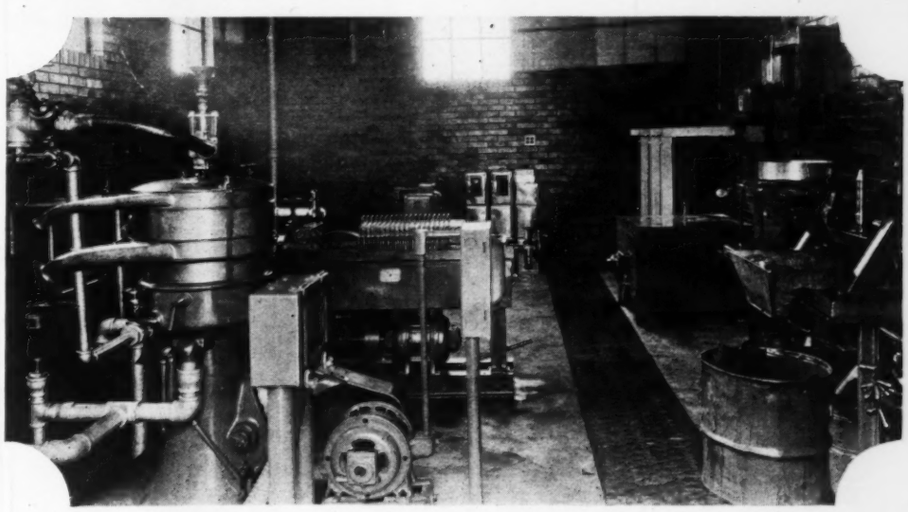
These oils to be safe for use must have a minimum dielectric strength of 22,000 volts when this potential is applied between 1-inch diameter discs spaced 1/10 inch apart.

Determination of Pipe Size

The first consideration governing the size of the pipe to use depends upon the speed with which it is desired to empty or fill a piece of apparatus. Opinion varies in this respect. A major limit of one hour for the largest piece of apparatus in the switchyard appears reasonable. Most of the apparatus will then be emptied or filled well within a half-hour. The "gallon per minute" flow through the pipe is thus determined.

The lowest temperature that it is expected to encounter during purification plays an important part in the selection of the proper size of pipe. It is not generally realized how greatly the viscosity of oil varies with the temperature. This is one of the reasons oil pipe calculations based upon applying a corrective factor to water pipe calculations so often do not check up in practice. Fig. 1 shows how rapidly the viscosity of switch and transformer oil rises with decreased temperature. For the average installation in this country, an assumption of 32 F is about correct as it is seldom necessary to purify oil in extremely cold weather. There are, however, some localities where 20 F will be a more conservative figure while 50 F would not be unreasonably high for some of the southern states.

In order to avoid too long a run from the most remote switch or transformer to the "dirty" oil pump in the oil house, the house should be located fairly central to the various pieces of apparatus in the switchyard. The oil is removed from the apparatus by suction and a total suction head of much over 20 ft. is not usually advisable.



IN THE LEFT FOREGROUND MAY BE SEEN THE CENTRIFUGAL PURIFIER AND BEHIND IT THE FILTER PRESS. THE RIGHT FOREGROUND SHOWS THE BOWL CLEANING BENCH AND TOOLS AND BEHIND THIS THE FILTER PAPER OVEN. THE MAIN POWER CONTROL SWITCHES MAY BE SEEN ON THE RIGHT WALL. THE PIT IN THE FLOOR IS USED FOR STORING FLEXIBLE HOSE

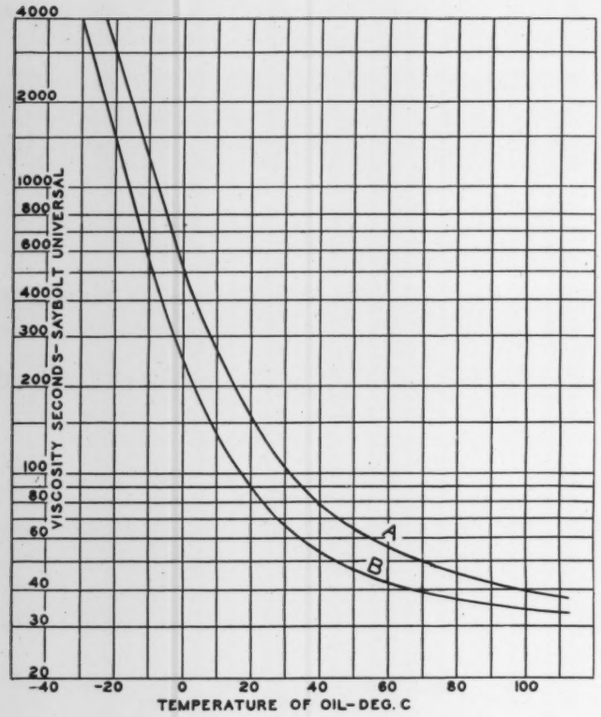


FIG. 1—THE VISCOSITY OF SWITCH AND TRANSFORMER OIL RISES RAPIDLY WITH DECREASED TEMPERATURE (OILS *A* AND *B* AS LISTED IN TABLE 1)

The proper choice of pipe size is also affected by the specific gravity of the oil for the temperature under consideration. For insulating oil this varies as shown in Fig. 2. The pipe size is thus determined by these four factors:

1. The flow in gallons per minute through the pipe.
2. The viscosity of the oil for the lowest surrounding temperature during purification.
3. The specific gravity of the oil for the lowest surrounding temperature during purification.
4. The length of run to the oil pump intake.

Loss of Head in Pipe

The loss of head for a given size pipe is then calculated from the Chezy formula:

$$H = f \times \frac{l}{d} \times \frac{v^2}{2g}$$

where

H = loss of head in feet
f = coefficient of friction
l = length of pipe in feet
d = diameter of pipe in feet
v = velocity of oil in feet per second
g = acceleration of gravity = 32.2

All quantities are known except f, which is a function of $\frac{dvs}{u}$

where

s = density in lb. per cubic foot
u = absolute viscosity in English units

$$u/s = 0.00000237t - \frac{0.00194}{t}$$

where t = viscosity in Saybolt seconds

Rates of Flow

Fig. 4 shows the relationship between f and $\frac{dvs}{u}$ and Fig. 3 shows the relations between Saybolt viscosity and $\frac{s}{u}$ for use in Fig. 4. From these curves and formulae the following tabulations were made for the three rates of flow shown and for the three temperatures mentioned. The data are based on the use of oil *A* (See Table 1) which is customarily used in one large concern's outdoor oil circuit breakers. This was selected because its viscosity is high and therefore represents extreme conditions.

LOSS OF FRICTION HEAD *H* IN FEET PER THOUSAND FEET OF PIPE

PIPE SIZE	50 G. P. M.			100 G. P. M.			200 G. P. M.		
	20 F	32 F	50 F	20 F	32 F	50 F	20 F	32 F	50 F
2	413	233	119	826	466	428 T	1652	1568 T	1438 T
2.5	169	96	49	338	192	99	676	384	497 T
3	81	46	23.7	162	92	47	324	184	210 T
4	26	1.5	7.5	52	30	14.9	104	60	53.5 T
5	10.5	6	3.1	21	12	6.1	42	24	12.4
6	5.0	3	1.5	10	6	2.9	20	12	5.9
8	1.5	1	0.5	3	2	0.9	6	4	1.9
10	0.7	0.4	0.2	1.4	0.7	0.4	2.7	1.5	0.8
12	0.3	0.2	0.1	0.6	0.4	0.2	1.2	0.7	0.4

T.—Flow at heads marked "T" is turbulent and creates large loss of head.

It is of interest to note from the above tabulation that, for the smaller size pipes operating at higher capacity, the loss at the higher temperature may exceed that at the lower, due to the fact that the decreased viscosity permits turbulent flow instead of stream line flow through the pipe with correspondingly larger loss of head.

Experience has justified the use of 5-in. or 6-in. pipes for suction dirty oil lines delivering 200 gallons per minute. Smaller size pipe may seriously cut down the pumping capacity. With clean oil lines, which operate under a positive head from the clean oil pumps, a larger head loss can be tolerated and 4-in. pipe is permissible. To the calculated friction loss of head must be added the static suction lift if the dirty oil pump intake is above the level of the apparatus tank outlet. Usually, however, this is not the case so that the head of oil in the apparatus aids the pump. In any case the writer believes the sum of the static and friction heads should not exceed 25 ft.

Check Size of Valves and Fittings

The electrical manufacturers generally supply valves and fittings of ample size on their apparatus so that these will not be the limiting factors for emptying or filling a tank in a given time. For very large transformers and oil circuit breakers, however, this point is worth checking as in some instances a demand for larger fittings has been warranted.

Connect Apparatus with Flexible Hose

The piping in the outdoor switchyard can be permanently connected to the transformer and oil circuit breaker by suitable valves and branches. The disadvantage of this method of piping is the fact that it affords no visual indication of a valve having been inadvertently left open, or of a leak slowly draining the tank. The consequences of such a contingency could obviously be quite disastrous. For this reason it is preferable to terminate the piping from the oil house a short distance from the apparatus by means of stand pipes and valves making the connection to the apparatus with flexible hose whenever purification is to take place. The stand pipe opening should be horizontal to avoid the flexible hose being bent into an inconvenient overhead loop when connecting to the apparatus. An angle valve best meets this purpose.

Flexible metallic (gasoline) hose is obtainable, having a metal liner covered with rubber, with an overall covering of canvas. Experience has shown that very little contamination of the oil will take place due to deterioration of the rubber. Such hose, if properly cared for, will easily last three years or more.

Importance of Tight Joints

It is important that all joints made with the hose are tight. Not only will leakage reduce the capacity of the dirty oil pump but the undue aeration of the oil will hasten sludging. The permanent piping should also be made oil tight. Some companies have resorted to welding of joints to attain this end. A paste of glycerine and litharge applied to the joints is often effective in limiting leaks. Bakelite varnish has also been used successfully.

Large floor-mounted oil circuit breakers have their three oil tanks permanently piped together as shown in Fig. 5, with a single connection to the flexible hose so that all three tanks can be drained simultaneously if desired. Framework mounted oil circuit breakers have a special three-way fitting as shown in Fig. 6. Transformer tanks are drained separately.

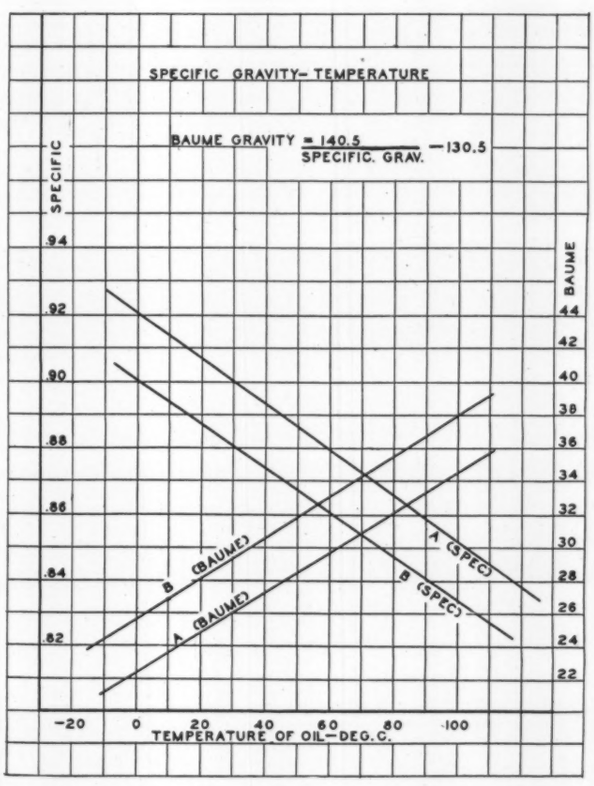


Fig. 2—Relation Between Specific Gravity of Oil and Temperature

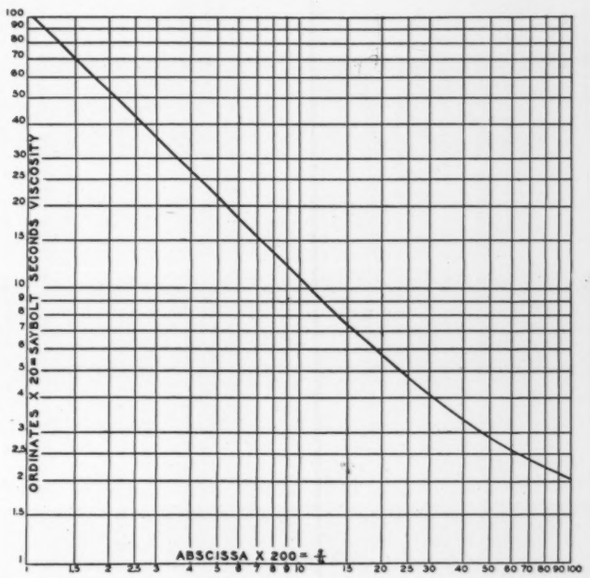


Fig. 3—Friction Loss in Oil Piping. Relation Between Saybolt Viscosity and s/u for Use in Formula

$$f = \phi \left\{ \frac{dvs}{u} \right\}$$

It is generally advisable to segregate the piping to various parts of the switchyard by means of valves near the oil house. This avoids filling all the piping when the oil of only a single piece of apparatus is to be changed. It also avoids sucking air from all the leaks in the entire suction piping system.

Opinion differs as to whether the clean oil pipes should be full or empty when not in use. If the pipes are left empty, moisture will find entrance and contaminate the oil subsequently discharged through the pipe. This, however, is not a serious objection if the first batch of oil is circulated from the clean to the dirty oil pipes. After the oil has been circulated in this manner for a few minutes the pipes will be clean and the oil can then be pumped directly to the apparatus. If the clean oil pipes are kept full at all times, it is necessary to maintain a slight head on them in order that all leaks may be outward. The inconvenience of installing head tanks for this purpose is one of the reasons against this arrangement.

Oil Storage System

The size and number of tanks used depend upon several factors such as the oil capacity of the largest piece of equipment, and the type of system employed. The 10,000-gallon tank appears to find most extensive application. Since both transformer and switch oil must generally be kept on hand, two clean oil tanks are required, and this, of course, is necessary whether one or two clean oil lines are used. It is not the intention to store dirty oil for any length of time, the object of the dirty oil tank being to enable rapid removal of the oil from a piece of

apparatus without the necessity of purifying it as fast as it is removed. The apparatus can then be filled from the clean oil storage tank and the dirty oil in the dirty oil storage tank purified at the comparatively slow rate imposed by the purifying equipment. It is then immediately transferred to the proper clean oil tank for storage. For economical reasons, therefore, a single dirty oil tank is justified, since it would be but rarely that both a transformer and an oil circuit breaker required change of oil simultaneously.

The most flexible system, of course, is one using four oil lines and four storage tanks.

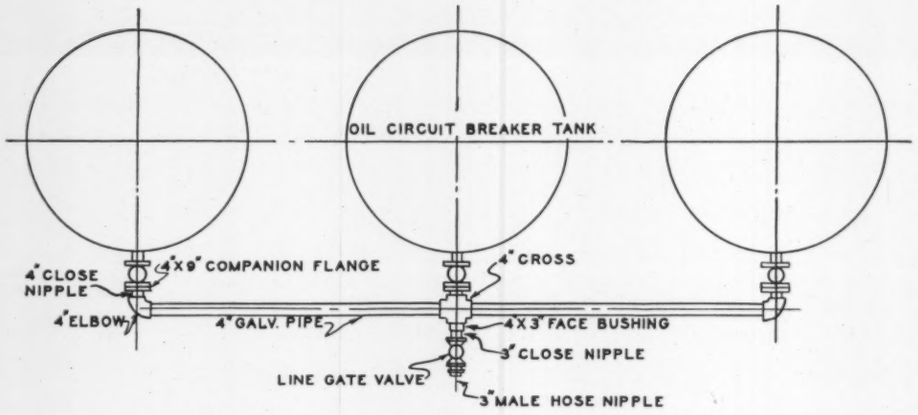


Fig. 5—Three Oil Tanks Piped Together for a Large Floor-Mounted Oil Circuit Breaker. A Single Connection to the Flexible Hose Permits the Three Tanks to Be Drained Simultaneously If Desired

The Tanks

Storage tanks are frequently mounted above ground, serious leakage of water sometimes having been experienced where tanks were buried in the earth. Either vertical or horizontal tanks may be used, the vertical tanks occupying less ground space, but the horizontal tanks probably making a better appearance. The horizontal tanks are supported on steel frames approximately 5 ft. above ground; the vertical tanks are set on concrete mats. It is not considered necessary to insulate the tanks thermally. Their exteriors should be painted to resist corrosion. For the interior of the tanks a good grade of non-volatile varnish is obtainable which will minimize corrosion, and will not cause contamination due to the oil dissolving the varnish. The varnish should be applied after all possible scale, dirt and rust have been removed from the interior of the tank and then allowed to dry for at least three days before storing oil in it.

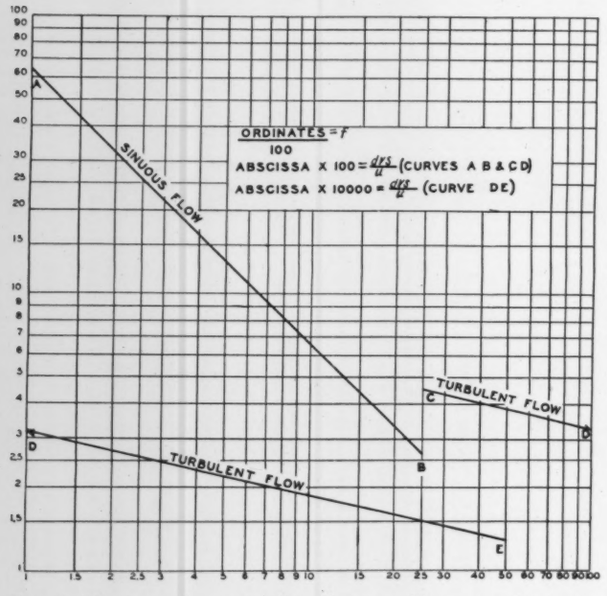


Fig. 4—Friction Loss in Oil Piping. Relation Between f and dvs/u for Use in Formula $H = f \frac{l}{d} \frac{v^2}{2g}$

Each tank should be provided with two manholes.

Tank Gages

Gage glasses in several sections have been used for indicating tank capacity. Quarter-inch sampling valves screwed into the heads of horizontal tanks or into the sides of vertical ones afford means of obtaining this information, eliminating any breakage of gage glasses. Several remote level indicators are now on the market which enable tank capacity to be read directly at any convenient point remote from the tank as, for example, the inside of the oil house. These should be calibrated to read directly in gallons and the precaution observed that the type of device supplied is suitable for the particular kind of oil with which it is to be used. Otherwise, large inaccuracies may result.

Sealing Clean Oil Tanks

Clean oil tanks should be sealed against direct contact with the atmosphere to prevent undue moisture breathing and excess aeration. Calcium chloride breathers aid in dehydrating the air breathed by the tank. Another device which is working satisfactorily is a mercury "anti-breather" which permits a pressure variation in the tank of 3 lb. above or below atmospheric pressure before breathing takes place. For large variations in pressure, as for example when pumping, the mercury seal in the device is automatically broken and pressure equalization between the inside and outside of the tank takes place. It is generally advisable to put valves on these breathers connecting to the atmosphere so that, when pumping from the tank, the valve may be opened in order to relieve the suction duty on the pump.

The breather pipe is taken from the top of the tank along the side where it connects to the breather itself.

Oil House Construction

The oil house varies in size and elaboration, depending upon requirements, taste and money available. The writer's company builds an oil house of brick, usually separated from other buildings at the plant, although in several instances it has been made part of the main building or combined with a storeroom or garage. The dimensions of the oil house alone are approximately 24 ft. x 15 ft. x 16 ft. high.

The equipment in the oil house consists of:

1. The incoming and outgoing pipes and control valves.
2. The large "clean" and "dirty" oil pumps for rapidly emptying and filling the apparatus.
3. A centrifugal purifier.
4. A blotter press and pump.
5. An oil heater for bringing the oil to the proper temperature for purification.
6. A small "dirty" oil pump to deliver the oil from the dirty oil tank to the purifying apparatus.
7. A combination deaerating and surge tank for removing the excess air from the oil leaving the centrifugal purifier and to provide for differences in rate between the discharge of the centrifugal purifier and the intake of the blotter press.
8. A filter paper drying oven.
9. An oil testing outfit.
10. Tank capacity gages.
11. Work bench, tools, sections of flexible hose and sundries.

The oil goes through the equipment in the following sequence: apparatus, large dirty oil pump, dirty oil tank, small dirty oil pump, oil heater, centrifugal purifier, deaerating tank, blotter press pump, blotter press, clean oil tank, clean oil pump, apparatus. The piping is designed to bypass any of this equipment or a return may be made to the dirty oil line for repeating the purifying process. Three-way valves accomplish this bypassing.

The incoming oil lines and valves are located in a pit at one side of the oil house. Gate valves are used. The pipes are painted to distinguish them, black for dirty oil, yellow for transformer clean oil, and red for oil circuit breaker clean oil.

The Pumps

All pumps are of the positive displacement rotary type. Relief valves are installed on all pumps between intake and discharge lines to prevent excess pressure building up. Pressure gages are placed on the discharge side of all pumps.

The small dirty oil pump capacity is, of course, based on the rate at which the purifier can handle the oil and its head should be chosen as ample to overcome pipe friction, static head and pressure drop through the heater.

Calculating Heater Capacity

The heater capacity will vary with the rate of purification. Its capacity is calculated as follows:

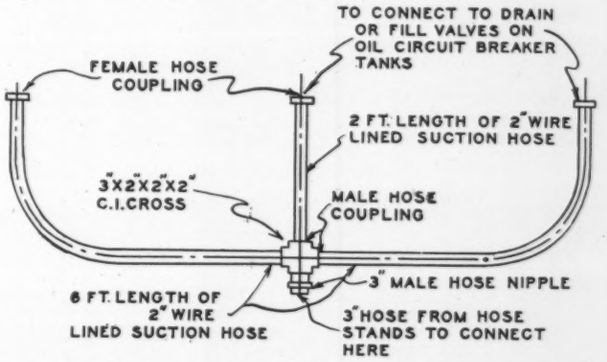
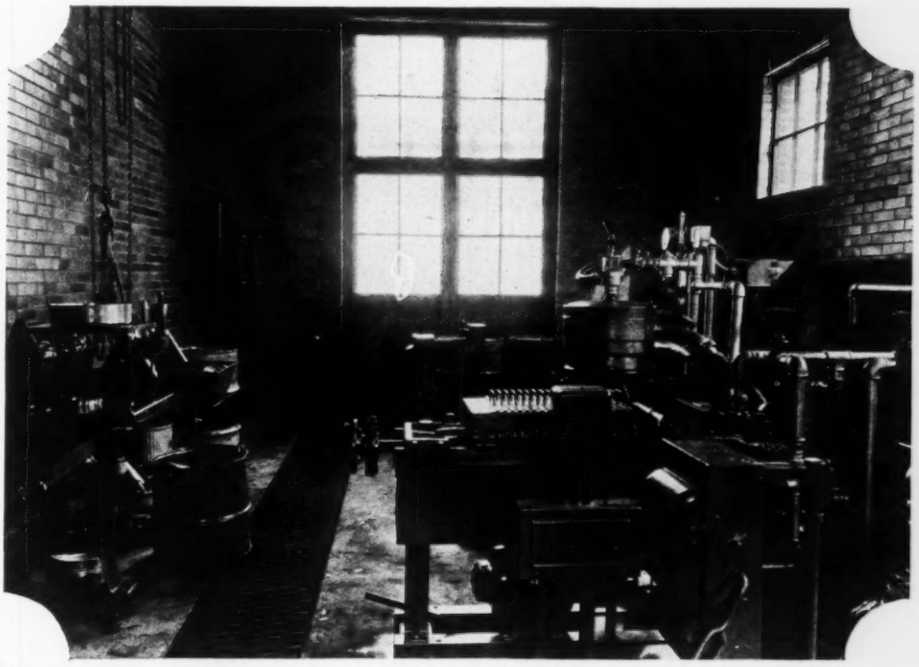

TO CONNECT TO DRAIN OR FILL VALVES ON OIL CIRCUIT BREAKER TANKS
FEMALE HOSE COUPLING
2 FT. LENGTH OF 2" WIRE LINED SUCTION HOSE
3"X2"X2"X2" C.I. CROSS
MALE HOSE COUPLING
3" MALE HOSE NIPPLE
6 FT. LENGTH OF 2" WIRE LINED SUCTION HOSE
3" HOSE FROM HOSE STANDS TO CONNECT HERE

Fig. 6—Oil Hose Unit for Framework-Mounted Oil Circuit Breakers

Specific heat of oil = 0.47 approximately
Pounds of oil per gallon = 7.25
Btu per kw-hr = 3415.

To raise the temperature of one gallon of oil 1 F requires $7.25 \times 1 \times 0.47 = 3.4$ Btu = 1 watt-hour, approximately.

That is to say, a rate of flow of one gallon per hour requires a power rate of one watt to raise its temperature 1 F. A typical installation purifying at 1000 gallons per hour requires 1 kw of power for each degree rise. The best purifying temperature appears to be 85 F. A heater of 54 kw is used which can raise 31 F oil to the proper temperature for purification. Colder oil for purification at higher rates may require the oil to be recirculated through the heater in order to attain the proper temperature.



Each Motor Is Controlled by Push Button or Safety Switch Adjacent to It. Note the Closed Inlet and Outlet Connection to the Purifier and the Sight Flow Glass

The heater is equipped with thermostat control, inlet and outlet thermometers, and relief valve, and is designed for three degrees of heat controlled from contactors and snap switches. To prevent burning of the oil, the contactors are interlocked so that the small dirty oil pump must be circulating oil through the heater before the heat can be turned on.

The Purifier

The centrifugal purifier is a standard make machine. For permanent installations a machine rated 1500 gallons per hour is used. In large power stations, two such machines are often installed.

A sight flow glass is placed between the heater and the purifier so that the flow of oil may be conveniently observed.

The clean oil outlet from the purifier should be piped directly through a flexible connection to the deaerating tank since oil fog through open discharge spouts causes considerable annoyance. This connection should run as directly as possible to the tank and should be large enough to handle the maximum discharge of oil from the purifier or the latter may overflow oil through its covers. By ventilating the deaerating tank with a pipe leading outside of the building the oil fog can be dissipated outdoors. Overflow and water discharge spouts are piped to a common drain line.

The filter press pump takes the oil from the surge tank and delivers it to the press. Its rate of delivery must be greater than the discharge rate from the purifier or the surge tank will overflow. This means that the surge tank will be emptied every so often and means must be used to prevent suction of air from the tank. A float switch is used which shuts off the pump motor when the oil has dropped to too low a level in the tank.

The filter press pump has a head sufficient to force the oil through the filter press and into either clean oil tank. The oil is discharged into the top of the tank and drawn out about 6 in. up from the bottom, so that any sediment and water that has settled will not be drawn out with the clean oil, but can be drained through a separate valve on the extreme bottom of the tank. A sampling valve is attached to the outlet pipe from the tank and is used for sampling and for filling oil drums with clean oil.

The filter paper drying oven and the test set are installed apart from the rest of the equipment, generally on the other side of the room. Pilot lamps indicate when either apparatus is in service.

Spare lengths of flexible hose are stored in a shallow pit covered by a grating at one side of the oil house.

The oil house is supplied with a separate 220-volt, three-phase, auxiliary feed of about 80 kw capacity for all the oil purifying, pumping and heating equipment, and for lighting purposes. After passing through the master switching cabinet individual feeds are taken to the various motors which are controlled by separate safety switches or contactors. The small dirty oil pump motor, being interlocked with the heater contactors, is controlled from the heater control cabinet.

A work bench is provided for convenience in cleaning apparatus, making repairs and testing oil.

Humidity in a Printing Plant

Increased efficiency in paper making, press building, ink making, photo-engraving and color printing has forced the printer to greater accuracy in his art. The first effort to overcome the printing troubles due to lack of humidity control in one plant was to keep the paper protected from the air till on the press, to run the key color on a day of normal relative humidity and to check the sheets from time to time as to size and alignment of the printing. When one of the colors did not register that press was stopped until humidity conditions were satisfactory. Often a number of days would elapse before the weather permitted operation. One summer the color press lost 1,078 hours in this way.

The next step was to close the doors and fire the boiler to increase the temperature and thus decrease the relative humidity so that color printing could be resumed during high humidities in the summer months.

As a new press room was to be installed, air conditioning equipment was purchased. An artesian well was drilled which supplied 50 gallons of water per minute. The temperature of this water was never over 57 F so that the relative humidity could be kept below 60 per cent. The air, water, steam and relative humidity were checked periodically in order to maintain constant conditions. The pressroom was supplied with temperature and humidity control while the adjoining book bindery had only temperature control but obtained a modified humidity through the pressroom. Of course, this plant was fortunate in having cold water available, but the same results could be secured with refrigerating equipment.

The results secured were continuous color printing in the summer, no static in the winter, better distribution of ink, less adjustment of rollers, longer life for the rollers, no tendency for coated papers to crack when folded in the bindery, elimination of dust from the atmosphere and forms, increased comfort for the workers and an opportunity to condition the paper before printing by storage in the pressroom for a week.—*Abstract by M. T.*

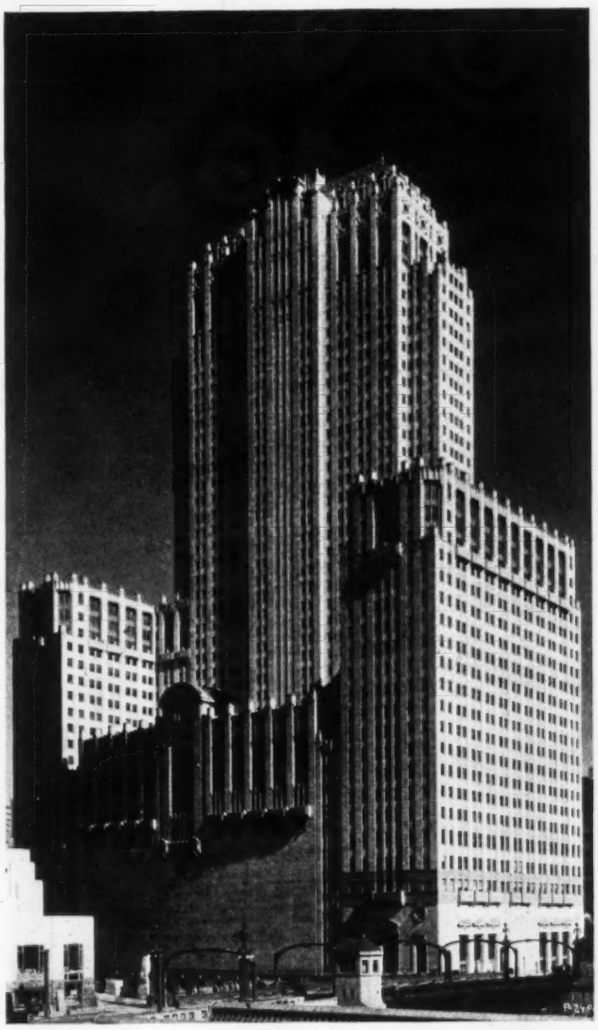
Cell Concrete

The heat insulating properties of cell concrete vary with the weight, the lighter concrete, having the great proportion of air cells, being the poorer conductor. Walls made of cell concrete weighing 70 lb. per cu. ft. are said to conduct only 0.4 of the heat lost through a brick wall of the same thickness.

Cell concrete has been used in Europe for the insulation of refrigerating plants, and buildings of various sorts, both on roofs and walls. Steam accumulators are often erected in the open and have been insulated with cell concrete. Oil stills, outside water tanks, and other equipment have been similarly insulated. Its use as a molded pipe insulation is extensive.

Direct and Indirect Heating System *in* Chicago Civic Opera

By Thomas R. Shaver*



THE 20 WACKER DRIVE BUILDING, CHICAGO, WHICH HOUSES THE CIVIC OPERA AND THE CIVIC THEATER. ARCHITECTS, GRAHAM, ANDERSON, PROBST & WHITE

THE Chicago Civic Opera is housed in the "20 Wacker Drive building," which is forty-five stories in height to the top of the tower shaft, and occupies the entire block between Madison and Washington streets, and from Wacker drive to the Chicago river. Besides housing the opera, it provides it with the income from this large commercial building.

The structure was designed by Graham, Anderson, Probst & White, architects; all engineering design and complete supervision was by the architects. Many superlatives could be used in a detailed description of the various features of the building. This article, however, will be limited to a description of the heating and ventilating system employed in the civic opera, which has successfully gone through one heating season. The provisions for heating and ventilating the civic theater are similar to those of the opera, and the description of the one will apply to the other, if the difference in size is kept in mind.

The entire lower section of the building, up to the courts, is occupied mainly by the opera and theater and their necessary entrances, foyers, check-rooms, rehearsal rooms, offices of the staff, and other incidental features, and by entrances and lobbies serving the office portion of the building.

* Consulting engineer, Chicago.

The Air Supply

The opera provides seats for 1698 persons on the main floor, 228 on the box mezzanine, 826 in the first balcony and 750 in the second balcony, a total of 3502. The heating of the auditorium is accomplished entirely by the air which provides ventilation; warmed air is supplied through 144 fresh air grilles in the main ceiling, which is at the fourth floor level, 80 grilles below the second balcony, 11 below the first balcony, and 28 below the box mezzanine, near the rear of the auditorium. The air is discharged through the grilles at a velocity of 250 feet per minute, and at a temperature averaging about 72 degrees. The maximum capacity of the heaters is an air temperature of approximately 85 degrees, with outdoor air at 10 degrees below zero.

Air Discharged at Forty-fifth Story

Air is exhausted through 74 mushroom ventilators in the second balcony floor, 84 in the first balcony floor, and 429 in the main floor. Plenum chambers are located in the two balcony cantilever trusses and below the first floor. Exhausted air is discharged at the top of the tower, forty-five stories above the street.

Air Is Filtered

The air intake is at the roof of the court. Air is drawn through cast iron preheaters, thence through horizontal sinuous type oil filters, fans, and reheaters. Temperature control is by thermostatic regulation of the heaters and of the dampers controlling the mixture of air from the preheater and reheater chambers.

Foyers, which are located at each seating level, are heated and ventilated in the same manner as the auditorium. Air is introduced through openings concealed by ceiling light fixtures, and through grilles in the walls. A pressure is thus built up in the lower foyer to offset the cooling effect of entrance door openings.

Amount of Radiation and Fan Capacity

The amount of radiation required for the heating of the auditorium, foyers, and such incidental rooms as check-rooms, totals 8,276 sq. ft. This amount of radiation, and the average discharge temperature of the incoming air, 72 degrees, is augmented by the heat supplied by occupants and lighting equipment. The air is moved by six centrifugal fans, two of which have a capacity of 19,950 c.f.m. each, two a capacity of 17,100 each, one of 28,150 and one of 34,170, giving a total fan capacity of 136,420 c.f.m. This is in excess of the ordinance requirement of 30 c.f.m. per person, the surplus supplying foyers and small rooms. Fans are insulated from the floors by cork mats, and ducts are separated from fans by canvas connections.

Provision is made for recirculating air for warming the rooms. At present, except during performances, the temperature is maintained at 60 degrees to 65 degrees, the air being recirculated.

Formal and Informal Attire a Problem

A very unusual condition exists in this auditorium, in that there are frequent "popular" performances. At these times the women patrons are more fully clothed than on the usual, and predominately formal, occasions, a condition which has made it necessary to design the system for varying temperatures needed to provide for the comfort of those in the auditorium.

Rooms other than the auditorium are heated either by the ventilating air or by direct radiation, depending on the location and use of the room. The fan room has direct radiation. In general, those rooms that are entirely separated from outside walls and direct natural ventilation are heated by mechanical ventilation. This applies to check-rooms, hospital rooms, and in general to first floor features. Some of the dressing rooms, on upper floors, are also treated in this manner. Other dressing rooms are at the outside walls and are provided with windows. These and other rooms similarly located are heated by direct radiation.

Projection Room Has Individual System

The projection room, on account of the possible danger from fumes, has an individual ventilating system, exhausting to the outside, and an additional gravity, or natural flow, outlet, for use in emergencies. Heating of this room is by direct radiation.

Provisions for Cooling

At present there is no cooling equipment, but provision has been made for future air washers, which will cool the incoming air somewhat by contact and dehumidification. This equipment will be installed if the auditorium is used later for summer performances.

Courts Increase Heat Loss

Two courts, open to the outer air at their tops, are provided at the sides of the auditorium, running north and south, one immediately back of the main elevator lobby on the Wacker drive side, and the other just inside of and parallel to the river wall. These courts are required by city ordinance, and make the heat losses greater than is apparent from a view of the outside of the building and an inspection of the interior of the auditorium. These courts contain fire escapes from all seating levels and are not heated. One similar court is provided south of the theater.

The Civic theater heating and ventilating plant, as stated before, is designed similarly to that of the opera. The main point of difference is that due to the difference in size. While the opera seats 3,502 people, the theater has a capacity of 500 on the first floor and 376 in the balcony, a total of 876. Dressing rooms, property, check, hospital and such rooms, are provided for both, and the description of the one applies to the other.

The Boiler Plant

Steam is furnished by a boiler plant consisting of three 500 hp. and two 250 hp. water-tube boilers. Steam is purchased from a company which is operating the plant under lease. The boiler room is under the north end of the building. Coal is received and ashes removed through the Chicago Tunnel Company connection with the building, coal being elevated by conveyors to hoppers serving the stokers, and ashes dropped directly into cars. Coal and ashes may also be handled from the street. Electrical power for fan operation, as well as other purposes, is supplied from the public utility sub-station in the basement in the south end of the building.

The pressure of the moisture, or water, in the air doubles about every 19 degrees for ordinary temperatures as the temperature is raised.

Above 100 F, this rate gradually decreases. There appears to be an impression that this increase in the vapor pressure, which in this case is the pressure of the vapor in the air, has an important bearing on the rate of drying. This is not the case. The important factor is that a difference between the possible vapor pressure and the actual vapor pressure be maintained. This means that, for a given temperature, the maximum possible vapor pressure, or 100 per cent relative humidity, can not be maintained if drying is desired and that the lower the relative humidity the faster the drying.

Heating·Piping
and Air Conditioning

American Society of Heating and Ventilating Engineers JOURNAL SECTION

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Capacity of Dry Return Mains for Steam and Vapor Heating Sytems

By F. C. Houghten[1] (*MEMBER*) and Carl Gutberlet[2] (*NON-MEMBER*), Pittsburgh, Pa.

THE capacity of pipe for carrying steam, condensate and air in various parts of steam heating systems has been under investigation at the A. S. H. V. E. Research Laboratory, and at Carnegie Institute of Technology, in co-operation with the Research Laboratory since 1922. A number of publications[3] have resulted from this study, giving the capacity of pipe for various parts of the steam supply side of heating systems. The practical application of these results has been made use of in the pipe sizes given in Chapter 20 of THE A. S. H. V. E. GUIDE, 1930.

Upon completion of the study of the supply side of steam heating systems a little over a year ago, the Society was asked to supply data on capacity of returns. The work on this study has since been carried on by the Laboratory staff in the heating and ventilating laboratory, Carnegie Institute of Technology, where suitable space for a test set-up, including a 22-ft. return riser and a 540-ft. dry return main, was available. This paper gives the results of tests on a 1-in. dry return main. Data were collected simultaneously on the capacity of return risers, but this phase of the study is not yet completed.

Test Set-up and Operation

The test set-up used for the investigation is shown in Fig. 1. The pipe and other equipment, however, were actually arranged other than shown.

Steam was supplied from a high pressure main *A*, through a suitable arrangement of throttling, by-pass, and pressure reducing valves to a 7-ft. section of 8-in. pipe *B*, so as to maintain the uniform pressure desired. From *B*, steam was taken through the 4-in. riser and distributing main *C*, *D*, *E*, to a battery of six unit heaters, *F* to *G*. The condensate from the unit heaters was collected in the 1-in. horizontal return *HI*, and was returned through the riser and 1-in. return main, *IJK* to the gravity receiving bucket *L*, or to the vacuum pump, where the non-condensable gases were liberated to the atmosphere and the water delivered to either of the two receiving tanks *M* or *N*.

The unit heaters were of several makes ranging in size from 2,200 to 150 equivalent square feet of direct radiation. The four larger units were drained through float-type blast traps with thermostatic by-passes for air. These connections are shown in Fig. 2. The two smaller units were drained through thermostatic traps as shown in Fig. 3. A water column gage glass was connected to indicate any water accumulation in the connection between the unit and the blast trap, Fig. 2, or the thermostatic trap, Fig. 3. Any of the units could be turned on at will and the fan speed of one of the larger units could be varied. With this arrangement any rate of steam condensation desired could be obtained and controlled.

Radiators of 28 equivalent square feet capacity were supplied with steam and drained into the return at points *O*, O_1, O_2, etc. The connections of these radiators are shown in Fig. 4. At points *P*, P_1, P_2, etc., along the return, additional provision was made for measuring the pressure in the return main besides at those points at which radiators were located. The arrangement for measuring the pressure in the riser is shown in Fig. 5. The arrangements for measuring the pressure in the return main are shown in Fig. 6.

Pressures were measured at points *P* and *O* along the return in order to indicate the pressure in the return at these points and by difference the pressure drop along the line for any condition of flow. The radiators were used in order to determine whether or not the return was overloaded at these points. If upon turning steam into the radiators the air was eliminated and the radiator heated up quickly, the return was considered not to be overloaded. On the other hand, if the radiator did not heat satisfactorily, the return was overloaded for the particular vacuum applied at the pump.

In the radiator connection, Fig. 4, a valve was placed between the thermostatic trap and the return so as to insure against water backing up into the radiator should the return be overloaded. In order to make a determination of the pressure in the return, at this point, the valve between the thermostatic trap and the return was opened and when the pressure in the radiator had adjusted itself to that in the return it was read on the manometer. Observation was also made of any water accumulation in the radiator as indicated in the gage glass. The steam supply valve of the radiator was then turned on to give a pressure of steam entering the radiator of 1 oz. above the pressure in the return as previously read in the radiator and the rate of heating up was observed. Observation was also made during the heating up period of any water accumulation in the radiator as indicated by the gage glass or any other peculiarity of operation.

The arrangement in Fig. 5 for measuring pressure in the riser was used in order to guard against the water backing up into the manometer. The pipe connection between the 2-in. nipple and the return was made large enough that water would not seal across it, but would drain out freely. The arrangement shown in Fig. 6 for

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[1] Director, Research Laboratory A. S. H. V. E.

[2] Research Engineer, Research Laboratory A. S. H. V. E.

[3] A. S. H. V. E. TRANSACTIONS AND JOURNAL, 1922 to date.

Presented at the 36th Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Minneapolis, Minn., June, 1930.

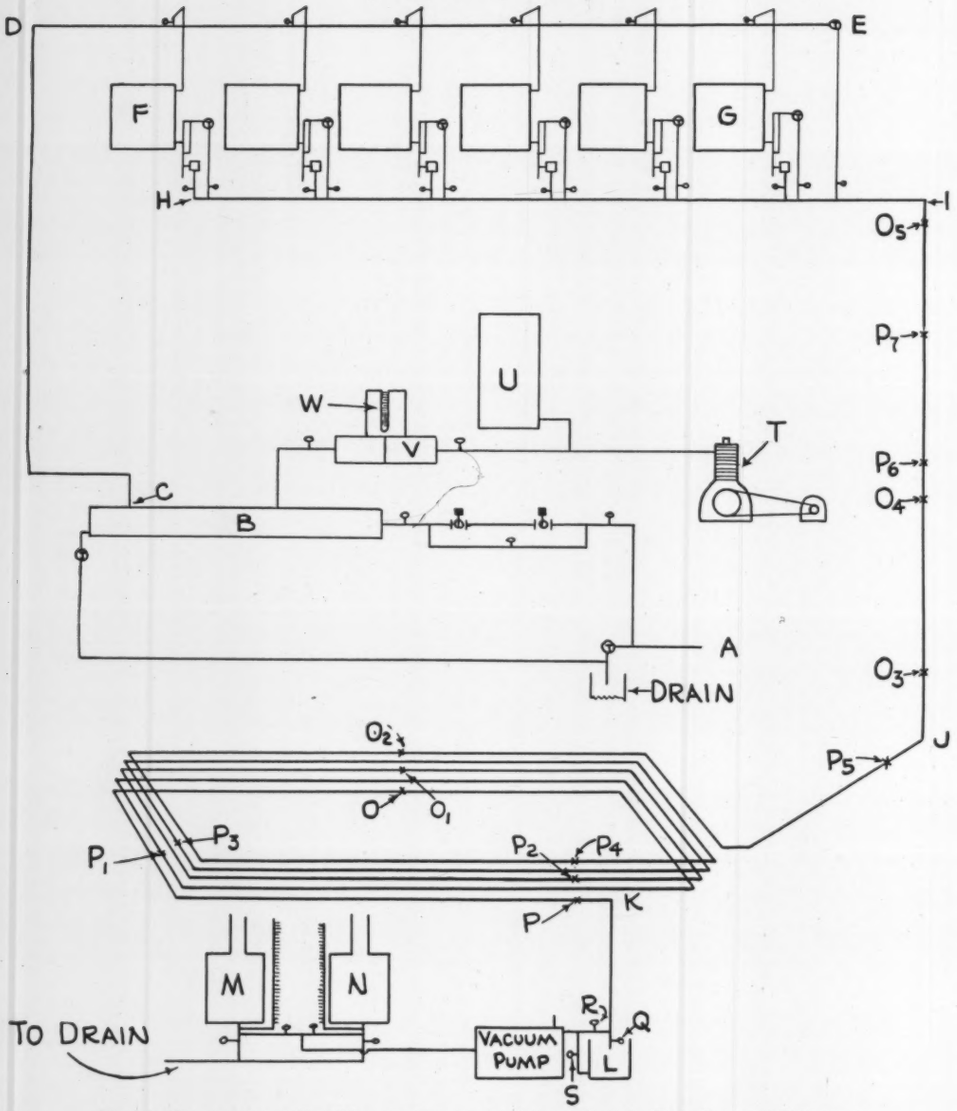


FIG. 1—LABORATORY SET-UP FOR STUDYING CAPACITIES OF DRY RETURN MAINS

measuring the pressure in the return main also insured against water backing up in the manometer or sealing across the pipe connection.

The system could be operated either by gravity return or by vacuum pump return. By opening valve Q, and closing valve R, the condensate returned by gravity, draining into the receiver L and by opening valve S the water contained in the receiver could be transferred as collected into the measuring tanks M and N. By closing valves Q and S and opening valve R, the system operated by vacuum pump return, the pump delivering the water directly to the measuring tanks. The measuring tanks were barrels of approximately 50-gal. capacity. Each tank was supplied with an upright extension above the barrel made by flanging on a two-foot section of 4-in. pipe. Each barrel was fitted with a gage glass so that the water level in the barrel or smaller chamber at the top could be determined easily. For accurate determinations of return condensate the measurements were always made with the water in the smaller constriction above the barrel so that a small error in the water level had little effect on the accuracy of results. Either measuring tank could be filled or drained at any time by operating the valves.

Soon after starting the study it was realized that the set-up described would give satisfactory data on the capacity pressure drop relationship for the return when only the non-condensible gases contained in the steam were being handled, excepting any small amount of air eliminated from the units or leaking into the system due to the vacuum. Since the amount of air handled by the system under these conditions was extremely small, the results obtained gave practically the ultimate capacity of the returns for handling condensate with a very minimum amount of air and the extremely high capacities found for these conditions demonstrated clearly that return pipe sizes for practical use must not be based upon these high values.

This naturally brings up the question of how much air the returns of a steam heating system should handle. Widely different estimates of this value may be made based upon various assumptions of the relative rate of air expulsion from cold radiators and of steam condensation. In a vacuum pump system, the problem is fur-

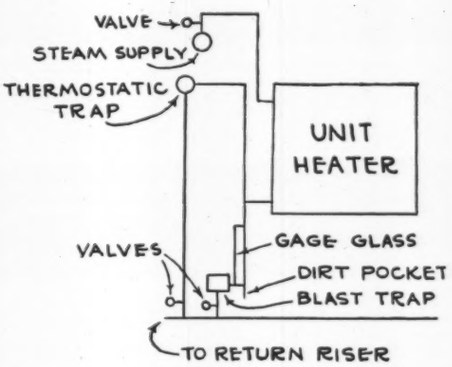


FIG. 2—DETAIL CONNECTION OF LARGE UNIT HEATERS

ther complicated by the probability of air leaking into the system through loose joints and fittings in poor installations.

Soon after starting the investigation it was realized that in order to base satisfactory tables for determining return pipe sizes on the results of the investigation, data must be established giving the capacity of the return for various rates of handling condensate and air. In order to make this possible, means were provided for supplying air into the system as previously described.

This was done by supplying air to the main *B*, Fig. 1, through a calibrated orifice *V*, from the motor driven air compressor *T*, and auxiliary storage tank *U*. With this arrangement the observer controlling the steam pressure in *B* could also control the rate of air supplied as indicated by the orifice meter *W*. The air admitted into the main was heated to steam temperature by the steam before passing through the units to the return side of the system.

In making a test under any specified condition of operation the steam pressure in the main *B* and the rate of air supply were regulated and held constant. The right number of unit heaters were turned on and the speed of the fan on the unit subject to regulation was adjusted to give the condensation rate desired. These conditions were then maintained until equilibrium of flow was established, after which test data were collected. During the test period the rate of condensation return as measured in the tanks was recorded and at the same time observations were made of the pressures at the various locations *O* and *P* along the return riser and main. The small radiators *O*, O_5 located along the return line were then turned on with a pressure on the steam supply end of the radiator one ounce above

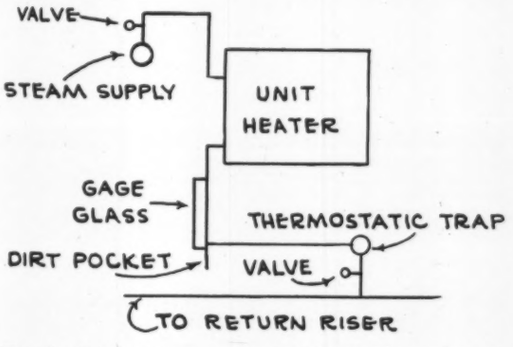


FIG. 3—DETAIL CONNECTION OF SMALL UNIT HEATERS

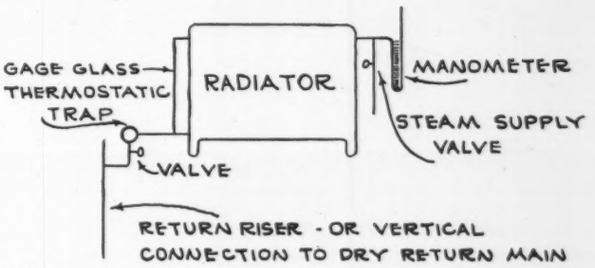


FIG. 4—DETAIL OF RADIATOR CONNECTIONS USED AS INDICATOR OF OVERLOADED RETURNS

the pressure recorded in the return at this point. The time required for eliminating air from the radiator through the return and entirely heating the radiator was observed. Any test in which a period of more than 20 minutes was required for eliminating air from and heating up the 28-sq. ft. radiators was not used.

Experimental Results

The pressure drops observed throughout the length of the 1-in. dry return main for several representative rates of condensation, air flow, and required vacuum at the pump are given in Fig. 7. From these curves

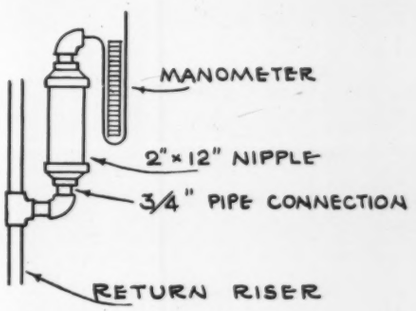


FIG. 5 — CONNECTION OF MANOMETER FOR MEASURING PRESSURE IN RETURN RISER

the pressure drop in ounces per 100 ft. length of run were calculated for use in determining the pressure drop, condensation and air flow relationships desired.

In all of the tests for any given condensation and air flow rates, the vacuum at the pump was adjusted approximately to allow the farthest radiator from the pump to heat up in about 15 minutes. It was soon found that the time required for the radiator to heat up bore a relationship to the pressure in the return at the point where the radiator drained into it. Whenever the pressure in the return reached 2 oz. above the atmosphere, the radiator would require an excessive time for heating regardless of the fact that the steam pressure at the entrance to the radiator was adjusted to one ounce above the pressure in the return.

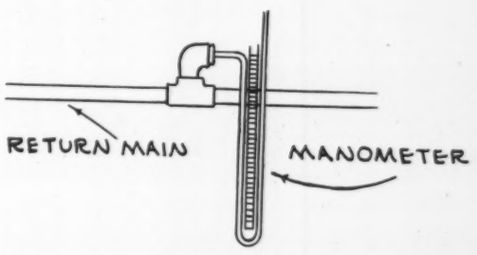


FIG. 6—CONNECTION OF MANOMETER FOR MEASURING PRESSURE IN RETURN MAIN

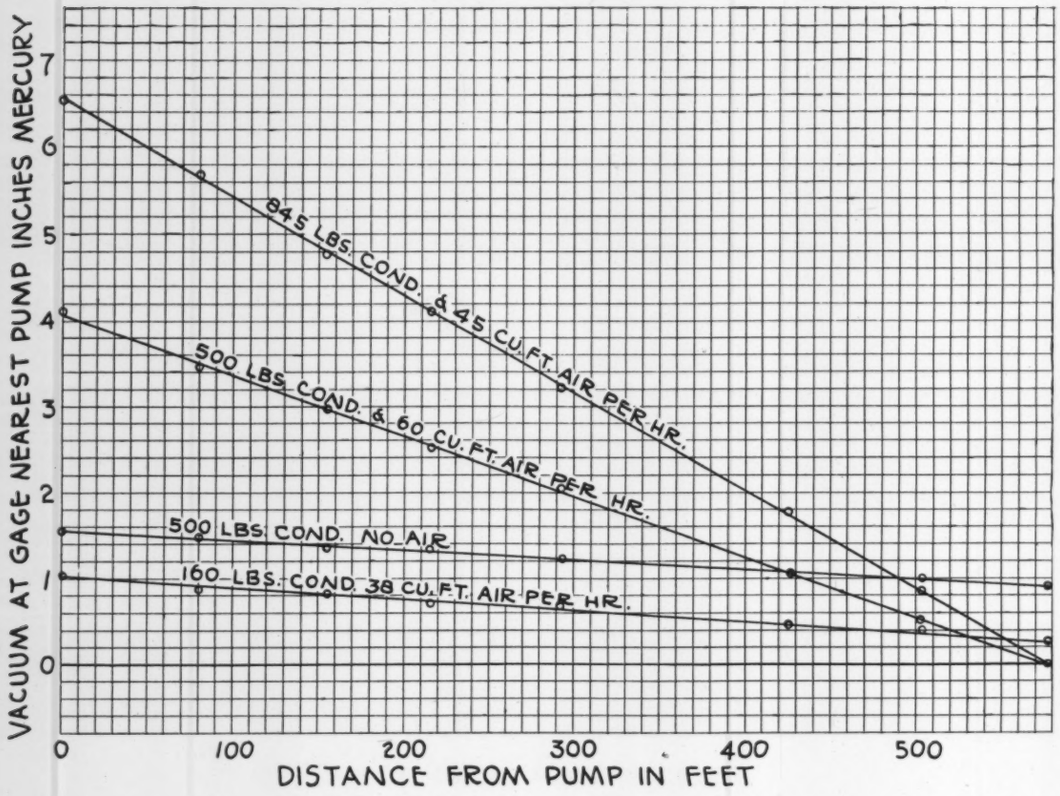


FIG. 7—PRESSURE DROP THROUGH THE DRY RETURN MAIN FOR VARIOUS AIR AND CONDENSATION LOADS

The relation between pressure drop in the main in ounces per 100 ft. length of run and the amount of air handled through the main in cubic feet per hour is given in Fig. 8 for several rates of condensation flow in a 1-in. dry return main. The points on the various curves were each obtained by averaging the pressure drops obtained from curves of individual tests as plotted in Fig. 7. The curves for loads ranging from 75 to 900 lb. of condensation per hour were each determined by a large number of tests made under most careful conditions. The curves for condensation rates from 1,200 to 1,900 lb. per hour are of relatively less practical value and these curves were determined by comparatively few tests under less favorable conditions. The limit in the quantity of air handled in the tests with loads of 75 and 160 lb. condensation per hour was fixed by the satisfactory operation of the system. Curve *A* gives the capacity of a dry 1-in. pipe for carrying air only as reported by O'Bannon.[4] Curve *B* gives similar data calculated from Unwin's formula. These two curves are of value in showing the degree to which the condensation carried by the main reduces the capacity of the dry pipe for carrying air only.

The relation between rate of condensation in pounds per hour or equivalent square feet of radiation based upon ¼ lb. per square foot, and pressure drop in the 1-in. dry return main in ounces per 100 ft. length of run, is given in Fig. 9 for various rates of handling air ranging from *no air added* to *90 cu. ft. air per hour.* These curves were developed from the curves for different loads, Fig. 8. From this chart may be derived the capacity of a return main for any desired rate of handling air or allowable pressure drop within reasonable limits.

[4] Simultaneous Flow of Water and Air in Pipes, by L. S. O'Bannon, A. S. H. V. E. TRANSACTIONS, Vol. 30, 1924, p. 157.

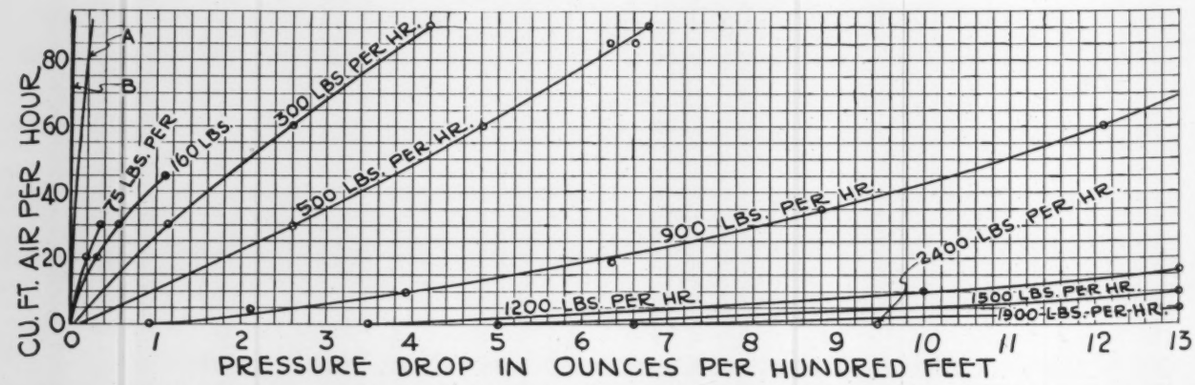


FIG. 8—RELATION BETWEEN PRESSURE DROP IN THE DRY RETURN MAIN AND AIR CARRIED FOR VARIOUS CONDENSATION RATES

The curves *A*, *B*, *C*, and *D* give the relationship between condensation load handled and pressure drop, based upon certain definite relationships between rate of air and condensation handled. These relationships were calculated to apply to various rates of heating up a cold system in which all condensation takes place in cast iron tubular radiation. As a result of measurement of the volumetric capacity of 15 tubular radiators of various sizes as sold by four of the larger manufacturers it was found that this type of radiation had an average capacity of 0.0142 cu. ft. per rated square foot of radiation. Assuming that air must be eliminated in a period of 20 minutes from an entire system containing all tubular cast iron radiation, air must be eliminated from the system at the rate of 3×0.0142 or 0.0426 cu. ft. of air per hour per square foot of radiation or 0.170 cu. ft. of air per pound of condensation handled. Curve *A* is based upon the limitation of air at this rate.

There is doubt regarding the justification of the assumption of this rate of air elimination. It has been suggested that to the air elimination from the radiators should be added the air elimination from the supply and return pipe. It does not seem logical, however, to add the air eliminated from the supply piping for the reason that an equivalent volume of air should be driven through the radiator and out through the return before the return begins to handle condensation, and as shown by curves *A* and *B*, Fig. 8, the capacities of the returns for handling air alone are extremely large compared with their capacity for handling air and condensation. Hence the elimination of air from the supply piping should be of little consequence, and since the returns are comparatively small it may likewise be assumed that the elimination of air from the return side of the system is no great factor.

It is probable that the tax on any system in eliminating air during the heating up period, even though the entire system is heated up at the same time, is much less than that indicated by curve *A*, for the reason that while the first portion of the radiators is being heated up, air

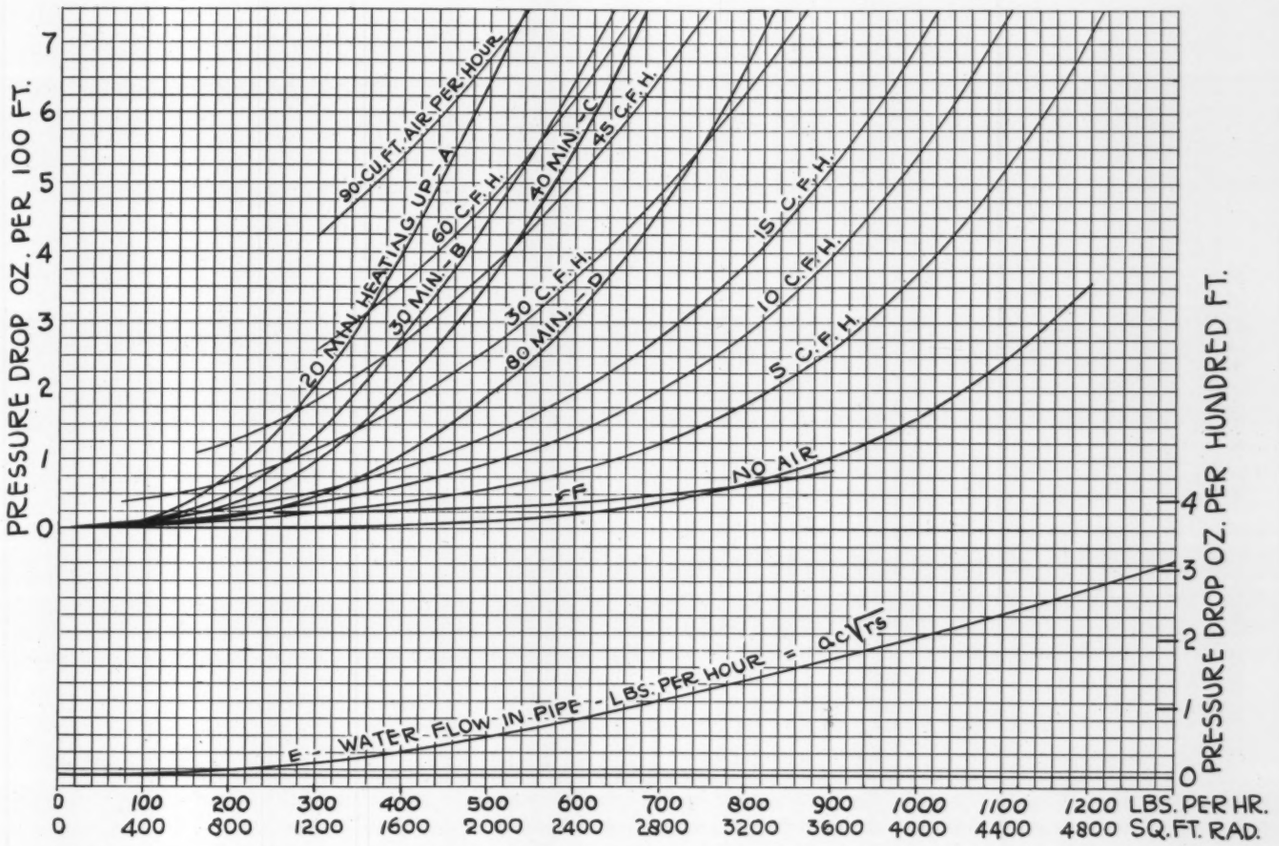

PRESSURE DROP OZ. PER 100 FT.
PRESSURE DROP OZ. PER HUNDRED FT.
90 CU. FT. AIR PER HOUR
20 MIN. HEATING UP - A
60 C.F.H.
30 MIN. - B
40 MIN. - C
45 C.F.H.
30 C.F.H.
80 MIN. - D
15 C.F.H.
10 C.F.H.
5 C.F.H.
NO AIR
FF
E - WATER FLOW IN PIPE - LBS. PER HOUR = aC√rs
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 LBS. PER HR.
0 400 800 1200 1600 2000 2400 2800 3200 3600 4000 4400 4800 SQ. FT. RAD.

Fig. 9—Relation Between Pressure Drop and Condensation Load for Various Rates of Air Elimination Through the Dry Return Main

from these portions is being eliminated through returns carrying much less than the indicated weight of condensate; hence the greater ease with which the system will be freed from air.

In many cases, it is not necessary to heat a system up in as short a period as 20 minutes and in comparatively few cases is it required that the entire system be heated up during the same time at this rate. Hence it would appear that curve *A* indicates relationships for air elimination at rates much higher than need usually be considered.

Curves *B*, *C*, and *D* indicate rates of air elimination of 66, 50 and 25 per cent of that indicated in curve *A*, or curves *B*, *C*, and *D* give the condensation pressure drop relationships for heating up periods of 30, 40, and 80 minutes, respectively.

The curve designated as *no air* gives the relationships for operating the experimental system when no air was being added to the system. This curve gives the relationship found when air was being eliminated from one

at a time of the small radiators located along the return and draining into it as a measure of whether or not the return was overloaded. It also carried the small amount of air leaking into the system due to the reduced pressure maintained by the vacuum pump and any non-condensable gases in the steam.

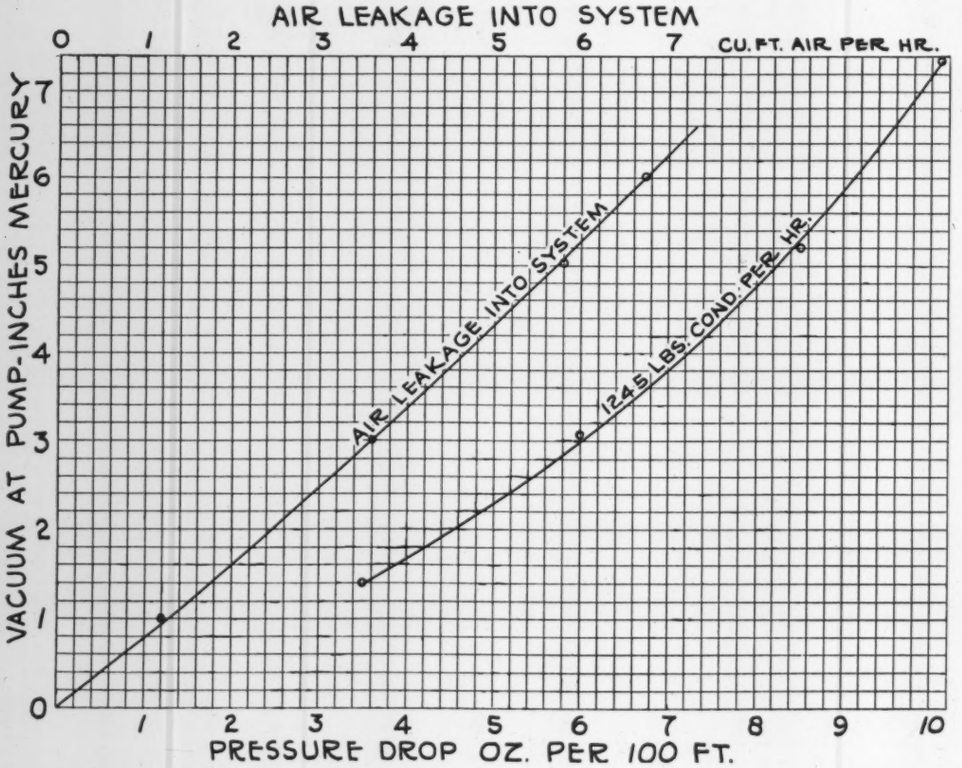

AIR LEAKAGE INTO SYSTEM
CU. FT. AIR PER HR.
VACUUM AT PUMP-INCHES MERCURY
AIR LEAKAGE INTO SYSTEM
1245 LBS. COND. PER HR.
PRESSURE DROP OZ. PER 100 FT.

FIG. 10—RELATION BETWEEN VACUUM AT THE PUMP AND PRESSURE DROP ALONG AND LEAKAGE INTO THE RETURN SIDE OF THE SYSTEM

The non-condensable gas in the steam supplied to the test system was very small and found by measurement to be 0.00018 cu. ft. of non-condensable vapor per pound of condensation. The rate of air leakage into the system due to the vacuum maintained is given in Fig. 10. This leakage was found when the supply valves to the unit heaters were closed off and the indicated vacuums were applied to the return and the unit heaters. Under operating test conditions the actual in-leakage would be considerably less than these values for the reason that under these conditions much lower pressures than maintained by the pump existed in other parts of the system. While these facts indicate that a very small quantity of air was actually handled in obtaining the data shown in the curve *no air*, Fig. 9, this curve represents conditions where the system was actually handling some air and non-condensable vapors and does not represent a true condition of water flow in a filled pipe.

In order to indicate the relation between the maximum condensation carried for any pressure drop as indicated by curve *no air* and the capacity of a similar pipe flowing full of water, the curve E was plotted based upon the following formula by Darcy:

$$Q = AC\sqrt{rs}$$

where Q = pounds water per hour flowing through the pipe.
A = area of the pipe
r = the mean hydraulic radius
s = the pressure drop
C = a constant.

The zero of this curve is dropped down to 3.61 oz. per 100 ft. length of run below the zero of the test curves; the value of 3.61 being the head produced in a 100 ft. length of pipe filled with water and having a pitch of 1 in. in 16 ft. The pressure drops indicated for the various curves in Figs. 7, 8, and 9 are based upon the difference in manometer readings giving the pressure differences between the interior of the main and the atmosphere at the various points of measurement along the line and these pressure drops do not include any head which might be created by the pitch of the pipe. If the pressure drops indicated in the test curves (Fig. 9) are the result solely of air flow in a space in the upper portion of the pipe above the water level of the returning condensate then the relative location of the zero pressure ordinates of the curve E and curve *no air* is correct. Otherwise it is not.

Curve F gives the relationship between the rate of water and air handled and pressure drop in a 1-in. test pipe as reported by O'Bannon. This curve is for a rate of handling air of 60 cu. ft. per hour. It shows a much lower pressure drop for the same rate of handling air than indicated by the similar curve established in this investigation. The reason for this becomes apparent when the different conditions under which the data were collected in the two investigations are compared. Curve F is for quiet, non-turbulent flow of water in the lower portion of a pipe with air flowing above. The test curves resulting from this investigation are for a condition of more or less turbulence as found in the actual test system.

In order to observe the degree of turbulence found in

the flow, a 3-ft. section of glass with 1.04 in. internal diameter was inserted in the dry return main immediately below the return riser. Under no condition of flow as regards rate of condensation or air handled was the flow of condensation found to be steady. On the contrary, it was found to flow in waves, filling a considerable portion of the pipe and occasionally all of it.

For condensation rates of 300 lb. per hour and higher the pipe was filled by waves as often as once per 2 minutes. When no air was being added the flow was less turbulent and when the pipe was filled it was by a slug of water rather than a short wave as was the case when large volumes of air were being handled. For loads of 150 lb. per hour and less the waves seldom reached the top of the tube. For no air added with these loads the water surface was little disturbed while with greater rates of air flow the surface was thrown into waves.

The turbulence in the pipe was probably caused by the disturbance incident upon the entrance of the condensate and air from the riser and also to intermittent passage of water and air through the traps.

Early in the investigation it was found that the pressure drop for a given rate of condensation flow varied over rather wide limits depending upon the vacuum applied to the return side of the system. This was particularly true for large condensation loads when small amounts of air were being handled. Fig. 10 shows the relation between vacuum applied and the pressure drop throughout the length of the return main.

It was first thought that the variation in pressure was due to air leaking into the system and as a result measurement of this leakage was made as previously stated and plotted in this figure. By adding additional air and measuring the increase in pressure drop it was shown that the air leakage could not account for the increase in pressure drop with increased vacuum at the pump shown in the curve. It was found, however, by computation that re-evaporation of condensation upon passing from the higher pressure on the unit heater side of the trap to the lower pressure maintained by the vacuum on the return side of the trap might account for the variation in pressure drop with vacuum.

A reduction in pressure of 1 in. in mercury results in the liberation of 3.5 Btu per pound of condensate at a steam temperature of 215 F. This is sufficient to re-evaporate $\frac{3.5}{970 \times 0.03802}$ cu. ft. of steam per pound of condensation or 42 cu. ft. of steam per hour for a condensation rate of 900 lb. per hour. Assuming that steam in the return had the same effect as air on pressure drop for a given rate of water flow, 42 cu. ft. of steam per hour with a 900-lb. load would be found from Fig. 9 to increase the pressure drop from one to approximately 9 oz. or 8 oz. per 100 ft. length of run.

It is of course true that all of this liberated heat will not be available for re-evaporation because of heat dissipation from the piping between the unit heaters and the traps and, further, the amount of steam formed will rapidly decrease by condensation due to heat dissipation along the return. However, it is probable that re-evaporation accounts in a large measure for the variation in pressure drop with vacuum maintained for a given condensation load as shown in Fig. 10.

The limitation of condensation and air loads, for gravity return is given in Fig. 11. Curves *A*, *B*, *C*, *D* give rates of air elimination corresponding to 20, 30, 40 and 80 minute heating-up periods respectively.

Practical Application of the Data

The relationships given in the curves Figs. 9 to 11 may be used for developing tables giving capacities of 1-in. dry return mains. The acceptance of such tabular values must, however, be based upon certain assumptions, including the allowable pressure drop, the rate of heating up or air elimination and any factor of safety desired for covering other contingent factors. These assumptions can not be determined by laboratory test but must be based upon experience gained through practice and judgment.

Table 1 gives the capacity of a 1-in. dry return main for various allowable pressure drops in ounces per 100 ft. length of run and various rates of air elimination based upon the elimination of 0.0142 cu. ft. of air per square foot of radiation during the heating-up periods.

In the application of the laboratory test data for sizing

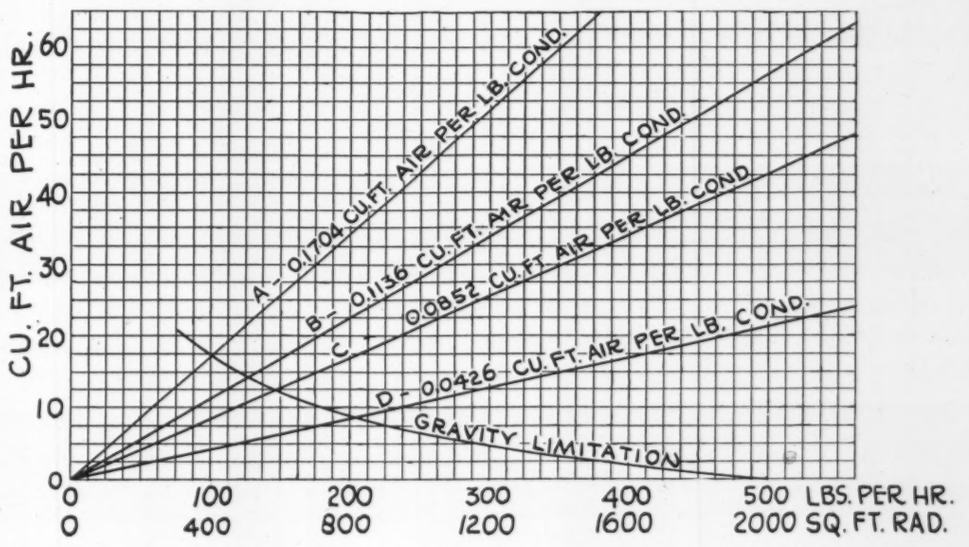

CU. FT. AIR PER HR.
60
50
40
30
20
10
0
A - 0.1704 CU.FT. AIR PER LB. COND.
B - 0.1136 CU.FT. AIR PER LB. COND.
C - 0.0852 CU.FT. AIR PER LB. COND.
D - 0.0426 CU.FT. AIR PER LB. COND.
GRAVITY LIMITATION
0 100 200 300 400 500 LBS. PER HR.
0 400 800 1200 1600 2000 SQ. FT. RAD.

FIG. 11—LIMITATION OF AIR AND CONDENSATION LOADS FOR GRAVITY OPERATION OF THE ONE INCH RETURN MAIN

TABLE 1—CAPACITY OF 1-IN. DRY RETURN MAINS IN SQ. FT. OF EQUIVALENT RADIATION FOR VARIOUS RATES OF AIR ELIMINATION. (EXPERIMENTAL RESULTS)

PRESSURE DROP—OZ. PER 100 FT.	PERIOD OF AIR ELIMINATION				
	20 MIN.	30 MIN.	40 MIN.	80 MIN.	NO AIR ELIMINATION
¼	512	586	684	940	2480
½	672	800	930	1160	2964
1	888	1060	1208	1560	3560
2	1180	1396	1568	2034	4200
3	1410	1648	1856	2368	4608
4	1600	1892	2096	2650	4936

TABLE 2—CAPACITY OF 1-IN. DRY RETURN MAINS IN SQ. FT. OF EQUIVALENT RADIATION FOR VARIOUS RATES OF AIR ELIMINATION. (EXPERIMENTAL RESULTS LESS 20 PER CENT FACTOR OF SAFETY)

PRESSURE OZ. PER 100 FT.	HEATING UP PERIOD OF					FROM GUIDE 1930[a]
	20 MIN.	30 MIN.	40 MIN.	60 MIN.	NO AIR ELIMINATION	
¼	409	468	547	752	1984	
½	537	640	744	928	2371	
1	710	848	966	1248	2848	700
2	944	1116	1254	1627	3360	994
3	1128	1318	1484	1894	3686	
4	1280	1513	1676	2120	3948	1400

a Capacities of dry return mains for vacuum installations. No rate of air elimination given.

TABLE 3—CAPACITY OF GRAVITY DRY RETURN MAINS IN SQUARE FEET OF RADIATION WITH CORRESPONDING MAXIMUM RATES OF AIR ELIMINATION. (EXPERIMENTAL RESULTS)

CAPACITY SQ. FT. EQUIVALENT RADIATION	MAXIMUM RATE OF AIR ELIMINATION	
	TIME[a]	CU. FT. PER HR.
200	7 min.	25
400	20 min.	17.5
600	45 min.	12
1200	240 min.	4.5
2000		0

a Time necessary for eliminating air from a system in which all steam is condensed in tubular cast iron radiation having a volumetric capacity of 0.0142 cu. ft. per equivalent square foot of radiation.

TABLE 4—CAPACITY OF GRAVITY DRY RETURN MAINS IN SQUARE FEET OF RADIATION WITH CORRESPONDING MAXIMUM RATES OF AIR ELIMINATION. (EXPERIMENTAL RESULTS LESS 20 PER CENT FACTOR OF SAFETY)

CAPACITY SQ. FT. EQUIVALENT RADIATION	MAXIMUM RATE OF AIR ELIMINATION	
	TIME[a]	CU. FT. PER HR.
160	7 min.	25
320	20 min.	17.5
480	45 min.	12
960	240 min.	4.5
1600		0

a Time necessary for eliminating air from a system in which all steam is condensed in tubular cast iron radiation having a volumetric capacity of 0.0142 cu. ft. per equivalent square foot of radiation.

pipe for the supply side of steam heating system, practical application has dictated the use of a 20 per cent factor of safety to cover variations in pipe capacity due to variations in pipe size, smoothness of pipe, constrictions due to improper cutting and other contingent factors.

Table 2 was developed from Table 1 by the application of a 20 per cent factor of safety. This is offered for comparison and is not necessarily recommended for adoption at this time.

Table 3 gives the capacity under which the system was found to operate satisfactorily with gravity together with the maximum rate at which air could be eliminated from a system of all tubular cast iron radiators. Table 4 is developed from Table 3 by the application of a 20 per cent factor of safety.

It is of interest to compare some of the values given in Tables 1-4 with capacities of dry return mains as found in the pipe size tables in THE GUIDE 1930. THE GUIDE gives capacities of dry return mains in vacuum return jobs as given in the last column of Table 2. These are seen to compare very closely to the results of this investigation for a 20-minute rate of air elimination, after the application of a 20 per cent factor of safety as given in the second column of the table.

THE GUIDE gives capacities of dry return mains in gravity return systems ranging from 284 to 460 sq. ft. equivalent radiation for pressure drops ranging from ½ to 4 oz. per 100 ft. length of run respectively. No rate of air elimination is given, however. Table 4 shows capacities, after allowing a factor of safety of 20 per cent, ranging up to 1,600 sq. ft. depending upon the rate of air elimination. The higher GUIDE value of 460 sq. ft. corresponds to a minimum time for complete air elimination of 25 minutes.

Summary and Conclusions

1. As a result of the investigation, curves in Fig. 9 give the relation between condensation carried by dry return mains, pressure drop through the mains, and air carried.

2. The volumetric capacity of tubular cast iron radiation is given for the average tubular cast iron radiator and based upon these values the relation between capacity and pressure drops is given for various rates of elimination of air from the system.

3. It is shown in Fig. 8 that the capacity of dry return mains handling condensation even at comparatively low rates have very much smaller capacities for handling air with a given pressure drop than the same pipe handling air only. It is also shown that the capacity of a dry return main for carrying water and air is considerably lower than the capacity of the same sized pipe for handling water and air with quiet flow. It is shown that this is probably due to turbulent flow in a dry return main caused by disturbances set up by entrance of condensate from risers and intermittent operation of traps.

4. The pressure drop in dry return mains increases with high vacuums maintained on the return side of the system for the same rate of handling condensation and air, probably caused by re-evaporation of condensation after passing through the traps.

5. Capacities of dry return mains are given in tabular form based upon laboratory results found and also by applying a factor of safety of 20 per cent to these results.

Carbon Monoxide Concentration in Garages

The results of cooperative research between the A. S. H. V. E. and Washington University.

A. S. Langsdorf[1] and R. R. Tucker[2], St. Louis
NON-MEMBERS

This report covers one phase of an extended investigation of the subject of carbon monoxide concentration in garages. It is proposed to carry on other phases later in a colder climate than St. Louis.

THE original purpose of the investigation described in this report was to discover what relation, if any, exists between the concentration of carbon monoxide, gasoline vapors, and other noxious gases in any part of a garage, and those structural features of the building which may have a bearing upon these data. It was originally intended to investigate a number of garages representing a variety of types of heating and ventilating equipment, such as direct steam heating, steam heating plus forced ventilation, gravity warm air heating, warm air heating with fans, and unit type heaters. After the beginning of the heating season in October, 1929, it was found after repeated visits to the garages selected for observational purposes that because of the mildness of the St. Louis winter practically all of them operate for the most part without using the heating equipment, and in most cases with open doors and windows, except for an hour or two about midnight. During the winter there was a period in December and January of exceptionally cold weather, and this time was utilized to the fullest extent to collect samples of air in the Henri Chouteau Garage, 14th and Howard Streets. By the time this work had been completed the severe cold was followed by milder weather, precluding the possibility of additional work elsewhere, for the reasons cited.

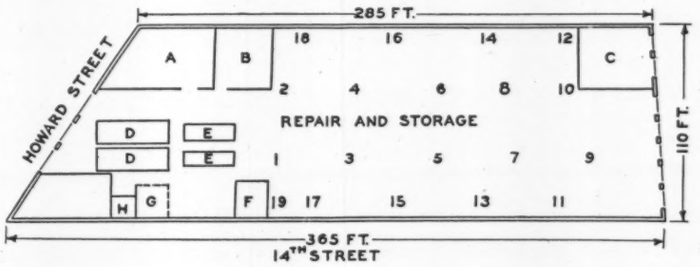


FIG. 1—HENRI CHOUTEAU GARAGE, 14TH AND HOWARD STS., ST. LOUIS. NUMBERS INDICATE SAMPLING STATIONS. *A*, MOTOR ROOM; *B*, STOCK ROOM; *C*, PAINT SHOP; *D*, WASH RACK; *E*, GREASE PIT; *F*, BLACKSMITH SHOP; *G*, FAN ROOM; AND *H*, HEATER

The garage in which conditions were studied was the only one of the types selected which is ordinarily operated with closed doors. Its general design and arrangement are shown by the floor plan, Fig. 1, and by the photographs, Figs. 2, 3, and 4. It has a maximum length of 365 ft. and a width of 110 ft., the volume of the building being 588,000 cu. ft. It is used to house the maintenance and repair departments of a transcontinental bus line. The main heating equipment, of the warm air type with blower, is located on the basement level in the southeast corner of the building, at the point marked *H* in Fig. 1. The intake takes place through an opening in the floor guarded by the grating shown in Fig. 3, and the discharge is near the ceiling of the main floor. This heating unit has a capacity of 58,000 cu. ft. of air per minute, corresponding to a change of air every ten minutes. Doors having an area of 39 1/3 sq. ft. are available for the admission of outside air to the fan, but they were not in use during the period covered by these observations. An average temperature between 50 and 60 F is maintained at all times. An auxiliary heater of the extended surface blast type is located in the northwest corner of the building to assist in the heating during unusually cold periods. The circulation of air in the building is in general along the longitudinal axis (south) through the main gallery and toward the southeast corner. This was checked by testing with a smoke cloud of ammonium chloride. In the vicinity of the pits for repair and inspection, the circulation is toward the center aisle.

The sampling stations, indicated by the numerals in Fig. 1, are about 50 ft. apart, and are located along four longitudinal sections of the building. The stations along the east and west walls are staggered with respect to those in the main aisles. All samples were

FIG. 2—EXTERIOR VIEW

[1] Dean, School of Engineering, Washington University.
[2] Assistant Professor of Mechanical Engineering, Washington University.
Presented at the Semi-annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Minneapolis, Minn., June, 1930.

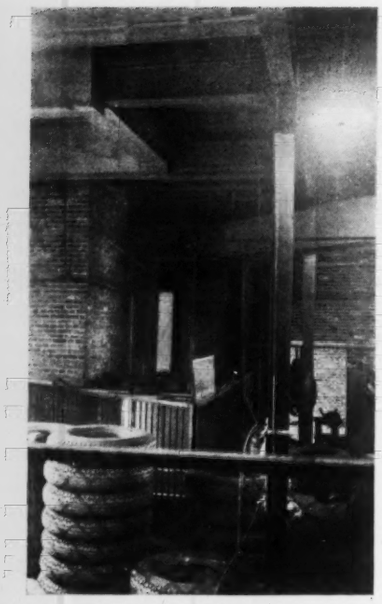


FIG. 3—FAN INTAKE

taken at a height of 4 ft. above the floor, using bottles of two liters capacity. The water in the bottles was first saturated with the air to be sampled. The samples were analyzed for *CO* content by the iodine pentoxide method described by Fieldner, Henderson, Paul and Sayers in connection with the study of ventilation in vehicular tunnels[3]. The apparatus for analyzing the samples is illustrated in Figs. 5 and 6.

Table 1 shows the average concentration at the stations indicated, throughout a month of observation, the samples having been taken between 2 and 3 o'clock in the afternoons. The samples were not taken daily, but only on those days when the doors had been closed during the greater part of the day.

Samples were not taken at varying heights for the reason that the work of Randall and Leonhard[4] shows that where there is a marked movement of air the diffusion is complete. In their work there was no variation in *CO* content between samples taken at floor level and at a height of 5 ft. above the floor.

The work of J. S. Haldane[5] in connection with the London Underground Railways shows that a *CO* concentration of one part in 10,000 is the maximum

[3] Ventilation of Vehicular Tunnels (Report of U. S. Bureau of Mines, JOURNAL A. S. H. V. E., Jan.-Dec., 1926).
[4] Airation Studies of Garages, by W. C. Randall and L. W. Leonhard (JOURNAL A. S. H. V. E., Oct., 1929).
[5] The Action of Carbonic Acid on Man, *Journal of Physiology*, Vol. 18, 1895.

FIG. 4—REPAIR AND STORAGE

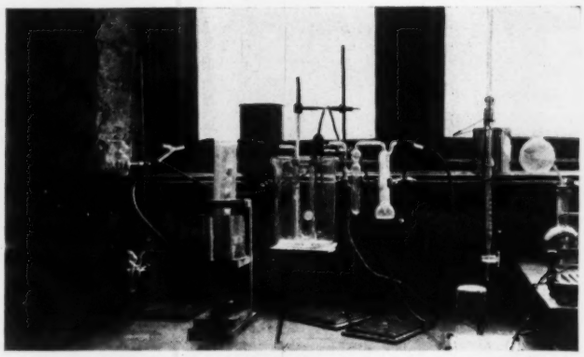


FIG. 5—GAS ANALYSIS APPARATUS

that should be permitted when there is to be exposure for a considerable time. Accordingly, it may be seen from the results indicated by Table 1 that considerable discomfort on the part of workmen in the building may be expected. A number of the men were questioned, and it was the general consensus that all suffered more or less, and that the effects were more noticeable when the temperature fell below the usual average. The majority of the men use aspirin to quiet the effects of the gas and reports of headaches and incipient nausea are common.

The roof of the main bay of the garage is fitted with a series of skylights and ventilators, but at no time during the sampling period were these ventilators open. There is no doubt that conditions would have been much improved had more outside air been circulated.

The average time required to take a sample was nearly 10 minutes, which is about the time to make a complete recirculation of the air in the building. Consequently, as samples are taken at different stations as the observer comes to them one after the other, the samples will represent different stages of the circulation cycle. Under steady conditions of operation this

TABLE 1—AVERAGE *CO* CONCENTRATION

STATION	*CO* PARTS PER 10,000
1	2.23
2	2.18
3	2.23
4	2.24
5	1.96
6	1.98
7	1.96
8	1.91
9	1.94
10	1.34
11	1.44
12	1.37
13	1.72
14	1.40
15	1.95
16	2.12
17	....
18	....
19	2.11
Fan Room	2.05
Office	2.71
Grease Pit	1.61

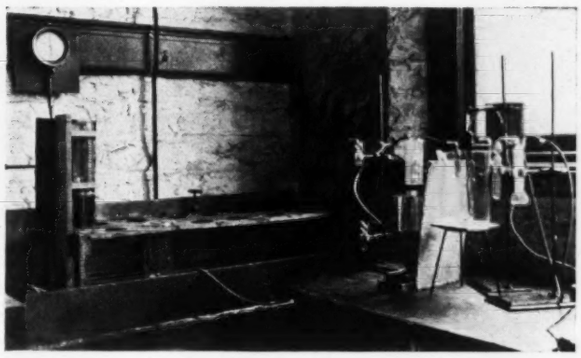


FIG. 6—GAS ANALYSIS APPARATUS

will not introduce serious discrepancies, but where conditions are changing rapidly, due to frequent car movements and opening and closing of doors, variations would occur. For strictly comparable results, the samples should be taken simultaneously and at frequent intervals, but this is hardly possible in a busy garage, even if there were enough observers to carry out such a program. Probably the best that can be expected is a record of average conditions at any given point.

The data presented in this report are not sufficiently extensive to justify final conclusions. It appears that the *CO* concentration increases as the fan intake is approached, and that elsewhere the concentrations in this particular building are higher than they should be.

A. S. A. Issues Periodical

The June 1930 number of the *A. S. A.* Bulletin is the first issue of the membership publication of the *American Standards Association.*

The Bulletin is intended as a record not only of the activities of the *American Standards Association,* but also of all important developments in the field of industrial standardization and specification work, both in the United States and abroad.

The following reports, appearing in the June issue, are of interest to the A. S. H. V. E.:

The establishment of national standards for pressure and vacuum gages was recommended at a general conference held in New York City on May 15 under the auspices of the *American Standards Association.* Thirty-five representatives of manufacturers and users of pressure and vacuum gages and of technical, governmental, and safety bodies having an interest in such gages were present at the conference.

In accordance with the recommendations of the conference, the scope of the committee's work will include nomenclature and definitions; rules and specifications for installation and use; method of testing; method of expressing allowable errors; accuracy requirements; capacity ratings, connections; indicator hands and stop pins; dials and graduations; bezel rings and attachments; case sizes and mounting holes.

The conference favored, in general, the development of specifications which would tend to unify the external features of gages of the indicating types, and permit a reasonable amount of interchangeability between the various makes.

Representatives of the steam power interests, petroleum, refineries, traction interests, gas and chemical interests were particularly eager to have the standardization undertaken. One group pointed out that at present it was necessary for them to carry in stock 72 gages of the same size in order to meet customers' demands.

The following organizations were represented at the conference: *American Electric Railway Association, American Gas Association, American Institute of Chemical Engineers, American Institute of Refrigeration, American Marine Standards Committee, American Oil Burner Association, American Petroleum Institute, American Society of Marine Engineers, American Society of Mechanical Engineers, National Association of Purchasing Agents,* National Board of Boiler and Pressure Vessel Inspectors, *National Electric Light Association,* New York State Department of Labor, *Refrigerating Machinery Association, Scientific Apparatus Makers Association,* Underwriters Laboratories, U. S. Bureau of Standards, U. S. Department of Commerce-Steamboat Inspection Service.

The following manufacturers of gages were represented: Acme Gauge and Instrument Co., Ashton Valve Co., Brown Instrument Co., Consolidated Ashcroft Hancock Co., Crosby Steam Gage and Valve Co., Foxboro Co., James P. Marsh and Co., Motor Meter Gauge and Equipment Corp., C. J. Tagliabue Manufacturing Co., and Taylor Instrument Co.

The organization meeting of the *A. S. A.* technical committee on the standardization of fuel oil was held on March 19. Lee Schneitter of the Electric Bond and Share Co. was elected chairman, and Dr. A. E. Flowers of the DeLaval Separator Co. of Poughkeepsie, N. Y., was elected secretary.

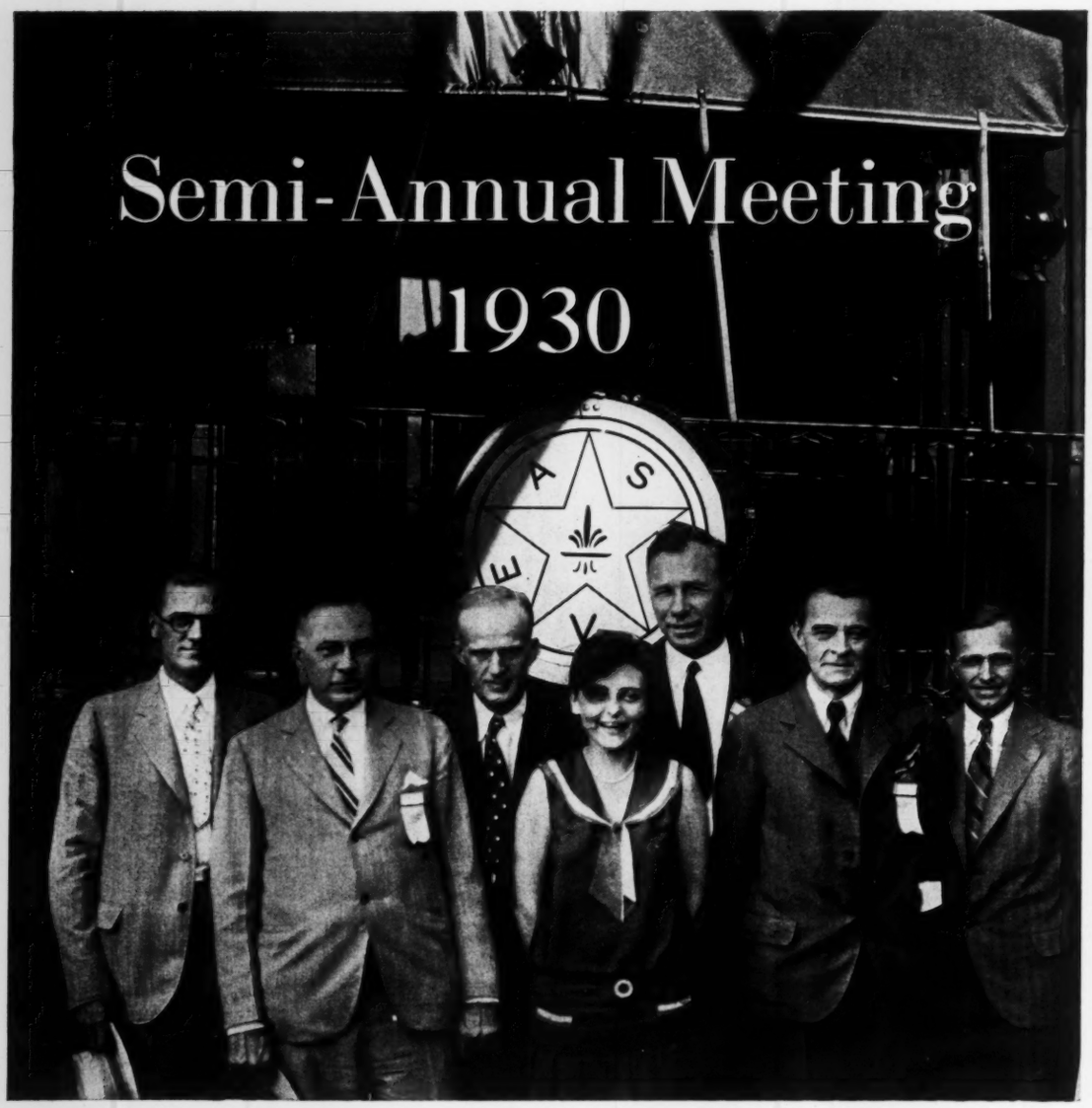
Two sub-committees were appointed to initiate the development of standard specifications for domestic and industrial fuel oil and for Diesel fuel oil.

The scope of the committee's activity, which had been agreed upon at an earlier conference is: "the preparation of specifications for fuel oil, including domestic, industrial, and Diesel fuels, and excluding oils with a flash point below approximately 100 F Tag. closed cup, oil burned in wick burners and oil for gas-making.

The sub-committee on domestic and industrial fuel oils, of which C. C. Ross of the Philadelphia Navy Yard is chairman, and H. F. Tapp, secretary of the *American Oil Burner Association,* is secretary, met after the meeting of the technical committee and voted to review the Federal specifications as a basis for the development of a proposed American Standard.

The sub-committee on Diesel fuel oil will be under the chairmanship of L. H. Morrison of *Oil Engine Power,* with W. H. Butler of the Standard Oil Co. of New Jersey as secretary.

A draft of the proposed American Tentative Standard for cast iron pipe flanges and flanged fittings for maximum working saturated steam pressure of 25 lb. per square inch; for maximum gas working pressure of 25 lb. per square inch; and for sizes of 36 in. and smaller for maximum non-shock working hydraulic pressure of 43 lb. per square inch, is available for review, through the *A. S. A.* information service. This draft has been approved by the *A. S. A.* technical committee on pipe flanges and fittings.



LEFT TO RIGHT—W. T. JONES, BOSTON; THORNTON LEWIS, PHILADELPHIA; W. A. ROWE, DETROIT; RUTH CAMPBELL, KANSAS CITY; JOHN HOWATT, CHICAGO; PRES. L. A. HARDING, BUFFALO; A. V. HUTCHINSON, NEW YORK

Proceedings of A.S.H.V.E. Semi-Annual Meeting 1930

A FINE program of technical features and entertainment events was thoroughly enjoyed by more than 300 members and guests who attended the Semi-Annual Meeting of the Society, Curtis Hotel, Minneapolis, June 24 to 27.

This pioneer visit to the gateway of the northwest will long be remembered because of the very successful meeting and the splendid hospitality of the Minnesota Chapter.

The Program Committee, A. C. Willard, Chairman, R. H. Carpenter and C. V. Eveleth, had provided subjects for discussion which were most interesting and the attendance at the sessions was a fine tribute to the authors of the technical papers.

Pres. L. A. Harding, Buffalo, called the meeting to order and E. F. Jones, president of the Minnesota Chapter, said that the Minnesota members felt deeply privileged in having the Society as its guests for the Summer Meeting, 1930. All of the members from the Twin Cities, as well as those from outlying cities in the state,

had cooperated splendidly to make the meeting a success, he said, and were ready to assist the visitors in making their stay in Minneapolis pleasant.

Mr. Jones then introduced the Mayor of Minneapolis, Hon. William F. Kunze, who said that as chief executive of the city, he was happy to extend a cordial greeting and hearty welcome to the members and felt that it is an honor to have representatives of so important a profession as visitors to the city. Gatherings of this kind, he said, were more necessary and important now than at any other time in the history of the country and offered the best means for progress in the industry.

After describing some of the attractions of the Twin Cities and telling a few appropriate stories the mayor expressed the hope that the Society members would enjoy their stay in the city and in conclusion said, "I do not know of any way in which I can express the confidence and respect that the Minneapolis people have in this gathering than for me to turn over to President Harding the official key to the City of Minneapolis. This key will admit you into any place where you ought to be and should you get into any place where you ought not to be, the key will let you out again. I trust that your deliberations here will be profitable and I feel sure that Minneapolis and the entire country will be the gainer because of the meeting."

President Harding, responding to the mayor's talk, thanked him on behalf of the members for the hearty welcome and said, "Much to my surprise I find that the mayor of this city is unusual as he formerly was a scientist and I presume still is. A scientist is only one jump ahead of an engineer."

A message from the *Institution of Heating and Ventilating Engineers of Great Britain,* whose summer meeting was being held on corresponding dates at Eastbourne, was received, also telegrams from two past presidents, Prof. A. C. Willard, Urbana, and J. R. McColl, Detroit, Mich., who expressed best wishes for a successful meeting and their regrets for not being able to attend. A message of greeting and an invitation to attend the National American Legion Convention in Boston, October 6 to 9, was acknowledged.

First Session—Tuesday, June 24—9:30 a. m.

Pres. L. A. Harding then opened the first technical session of the Semi-Annual Meeting, 1930, at the Curtis Hotel, Minneapolis, Minn., announcing as the first presentation the paper, The Economic Use of Steam in Modern Buildings, by F. A. Gunther, Pittsburgh, Pa. Presentation was made by F. C. Houghten, Director of the Society's Research Laboratory, who said that the material given by the author was based on his experience as chief engineer of the Alleghany Steam Heating Co. (Complete text of this paper appears in the A. S. H. V. E. Journal Section—HEATING, PIPING AND AIR CONDITIONING, June 1930, p. 527).

In a written discussion, S. S. Sanford of Detroit said that the paper was of considerable interest to engineers engaged in supplying district heating service, and stated that the method of comparing steam consumption of buildings on the basis of installed equivalent direct radiation would be correct if the ratio of installed radiation to heat loss were constant for the buildings being compared. Unfortunately, this ratio varies considerably according to the extent to which an excess of radiation is provided. This is especially true in buildings heated by indirect radiation. Where heat loss data are not available, it had been the writer's experience that comparisons based on building volume give more consistent results than those based on installed radiation. Such comparisons should be limited, he thought, to buildings in the same class and allowance should be made for the shape of the building. Another basis of comparison is steam used per square foot of exposed surface.

Fig. 2 would be less confusing, he felt, if outdoor temperature were used in place of degree-days per day. The shape of the curve appears to indicate that steam is used wastefully in warm weather. This is because of the way in which degree-days are calculated. If the degree-days had been based on 70 deg. instead of 65 deg., the curve would have been more nearly horizontal.

Mr. Sanford pointed out that steam consumption was often higher than necessary where controls were operated by indoor temperatures, and thought that better economy would result through the use of radiator orifices where control was in the hands of a central operating force.

The next speaker was D. S. Boyden, Boston, who stated that contrary to the author's opening statement it was his opinion that much had been done toward the reduction of overheating in modern buildings by the use of differential pressure systems, dual control, balanced orifice, duo-stat and zone systems. The speaker said it is the experience of district heating system operators that it is almost impossible to get all buildings on the same basis, and because of differing mehods in the calculation of radiation, building size or volume have been used for comparison and estimate. He pointed out that the term "equivalent direct radiation," if determined by a universally accepted standard, would be useful. Mr. Boyden then gave a suggested method of comparing the steam consumption for buildings.

In the absence of George W. Martin, New York, his discussion was presented by Paul D. Close. Mr. Martin was in agreement with the author regarding the reliability of comparing buildings on the basis of square feet of equivalent direct radiation, and quoted the schedule used by W. J. Baldwin, Jr., of the New York Steam Corp., for checking the economy of steam usage in various types of buildings.

F. I. Raymond, Chicago, Ill., said that he was not entirely in agreement with the curve shown in Fig. 2, and quoted a study of the Indianapolis Power and Light Co. with reference to the steam consumption per degree-day and the method used for determining whether a building is economically operated.

M. W. Campau, Detroit, said that in his city space calculations were made on the basis of inside dimensions of heated spaces, whereas architects usually use outside space dimensions in their calculations. The use of space rather than radiation figures by the Detroit Edison Co. was caused by the impossibility of accurate comparison between buildings used continuously and those used intermittently, and having a large amount of indirect radiation. Records of demand rates in Detroit indicate that

buildings having a large consumption of steam per degree-day in milder weather as compared with severe weather, are those which have a large water heating load.

F. D. Mensing, Philadelphia, said that the use of the cubic content method by a heating engineer was a step backward, and cited two examples which indicated the difficulty of using this method. He further stated that the only way to calculate radiation load was according to the A. S. H. V. E. GUIDE. He indicated that John Cassell, Philadelphia, could give some interesting information regarding closing down of a heating plant for brief periods.

John Cassell, Philadelphia, stated that his experience had been confined to school houses, but he had found no trouble in heating buildings with an ordinary plenum system, with slight exception on Monday mornings after very severe weather on Saturday and Sunday. Where heat is shut off on Friday afternoons, no difficulty is experienced in bringing the temperature of the room to 70, but even with a 70 deg. temperature in the rooms reports are often received complaining of cold feet. This condition has been corrected by installing direct radiation particularly in corner rooms. When indirect systems, with reheaters under each set of flues, were installed, no complaints of cold corner rooms were received, he said.

President Harding, in closing the discussion, said that the steam load curves for buildings, reported by the public utility corporations were very interesting, particularly as the problem of heat capacity of walls and the sun effect on buildings is to receive more study. He expressed the opinion that the public utility engineers can render a great service to the Society by furnishing data on daily load curves as they will be most valuable to the committee undertaking the study of sun effect on walls, roofs, etc.

In a written discussion the author, Mr. Gunther, commented on the remarks of the speakers at the meeting. With reference to Mr. Boyden's comment on the reduction of over-heating attention was called to the fact that with the exception of schools comparatively few large buildings in the past 25 years were equipped during construction with temperature control systems.

Answering the questions of Messrs. Sanford, Raymond and Mensing on Fig. 2 of the paper, it should be noted that this gives all of the steam consumption in any heating system including that of mains and risers. Mr. Gunther mentioned various methods of control used; supply for radiator only, manual control of mains and risers, automatic methods, and said that it was difficult to picture the results obtained with some of the control apparatus now available, for the results in the majority of cases would closely approximate the curve given in Fig. 2.

Control Equipment for Gas Burner Heating Appliances, by W. E. Stark, Cleveland, O., was presented by the author who said that the paper covered present-day control equipment for gas burning boilers and furnaces. (Complete text of this paper will be found in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, July, 1930, p. 617).

President Harding inquired whether any discussions were to be offered, and F. I. Raymond, Chicago, stated that when outdoor temperature is used as an operating control, an even heating curve is likely to result, which in many cases may produce a period of overheating. The speaker also believed that there was an opportunity for improvement in control equipment, and felt that important additions would be made to the list given in the paper.

President Harding said that reports would be heard from the Guide Publication Committee and the Committee on Research before concluding the session.

The report of the Guide Publication Committee, presented by Chairman D. S. Boyden, was given as follows:

Report of the Guide Publication Committee
By D. S. Boyden, Chairman

In compiling the ninth edition of THE GUIDE, the Committee is striving to keep pace with the rapid progress of the industry by revising old data to conform to present standards, by adding new material and by eliminating that which is obsolete. It is not the purpose of this Committee to outdo its predecessors, but rather to fulfill its obligation to the Society and to Guide users by making the book as useful and complete as is possible in the light of present available information. Every possible source of information is being used to maintain the high standard of THE GUIDE which has received such wide recognition as the outstanding publication in the heating and ventilating field.

The personnel of THE GUIDE 1931 was completed by May 1, 1930, and about one-third of the revised chapters have already been received. The Committee has been fortunate in enlisting the cooperation of men of outstanding ability for each of the chapters. In practically every case, the associate editors selected are preeminent in the subject for which they are responsible, and each chapter can therefore be relied upon as being an authoritative source of information on that subject.

THE GUIDE 1931 will contain 36 chapters, two of which, Fan Steam Heating and By-Products in Heating, are new. The chapter on By-Products in Heating will include a discussion of Exhaust Steam Heating, and will also include such other data of this nature as are available and appropriate. Some of the material from the paper, Power from Process and Space Heating Steam, presented at the 1930 Annual Meeting in Philadelphia by President Harding, will be incorporated in this chapter.

Chapter 2 of THE GUIDE 1930 will be divided into four parts in THE GUIDE 1931, three of which will be separate chapters, and the fourth of which will be a part of Chapter 34, Special Applications of Heating and Ventilation. The chapter on Ozone will be eliminated and a brief discussion of this subject included in Chapter 34, as well as a discussion of Ionization of Air.

The two chapters designated in THE GUIDE 1930 as Air Conditioning and Drying will be treated as correlated chapters in THE GUIDE 1931, and will be designated as Air Conditioning for Comfort, and Air Conditioning for Processing and Drying. In THE GUIDE 1930, the discusion of Unit Air Conditioners and Unit Air Coolers was included in the chapter on Unit Heaters and Air Conditioners. In THE GUIDE 1931, this discussion will be included in the Air Conditioning chapters. Automatic Heat and Humidity Control will be treated in the same chapter in THE GUIDE 1931, although previously these subjects have been treated in separate chapters.

The chapter on Air Ducts has been expanded to include Dampers, Registers and Grilles. Instead of treating Pneumatic Exhaust Systems as in Chapter 28 of THE GUIDE 1930, the subjects of Smoke, Ash and Cinder Treatment will be treated in Chapter 33 of THE GUIDE 1931, as these are considered more closely related to the industry. It is proposed to treat a number of miscellaneous phases and problems relating to heating and ventilation in the Special Applications chapter.

The financial outlook of THE GUIDE 1931 is very favorable. The budgeted income from the Catalog Data Section is $36,500

and already more than 60 per cent of this amount has been contracted for. This is an exceptionally high percentage for this time of the year, particularly in view of the fact that the deadline for copy is still several months away.

The splendid cooperation of manufacturers who have inserted their catalog data in THE GUIDE has helped to increase its usefulness. THE GUIDE is essentially a limited-profit publication and any increase in the amount of catalog data not only increases its usefulness for that reason, but also makes it possible to widen the scope of the material covered in the Text Section. Furthermore, since the difference between income and cost of production goes to the Research Laboratory, any increase in the Catalog Data Section makes possible an increased amount of research investigation, which therefore comes back to the Text Section of THE GUIDE.

It is the intention of the Committee to print 12,000 copies of THE GUIDE 1931.

Prof. F. B. Rowley, Minneapolis, Minn., was introduced, and briefly outlined the program of the Committee on Research, and then called upon Director F. C. Houghten to give a detailed report on the various projects.

Report of the Committee on Research
By F. B. Rowley, Chairman

Policies

1. The policies of the Committee on Research must necessarily be governed by the wishes of the Society.

2. In general, these policies have been fairly well established by past procedure. There are, however, specific occasions arising from time to time that require a modification of or the establishment of new policies.

3. *Regulations Governing Research Committee.*

At the Annual Meeting of the Society, a set of regulations amending and bringing up to date all previous regulations governing the activity of the Committee on Research and the Research Laboratory was adopted by the Society. In adopting these regulations, special attention was paid to the question of the Laboratory engaging in commercial research or testing for allied organizations. As a result of this consideration, the permission of the Society for the Laboratory's engaging in such work was re-affirmed and an accepted procedure for undertaking such work was adopted. While commercial research and testing were not made mandatory, the discussion leading up to the adoption of the new regulations emphasized the desirability of the Laboratory engaging in such work under proper conditions and safeguards.

4. One point in which there has always been somewhat of a variation of opinion is in regard to the amount of work which should be done at the Central Laboratory at Pittsburgh in proportion to that which is carried on through various co-operating laboratories. The present policy which seems to have many advantages is to carry on both as needs require without any specific regulation covering the proportion between the two. There is an advantage in the co-operative project in that a broader interest is enlisted in the Society's research work and that many facilities are available both in Laboratory and in trained technical men for carrying out special work which would not be available if confined to one central laboratory. On the other hand, it seems desirable at all times to maintain a Central Laboratory to properly correlate the work, carry on those projects which are not particularly well adapted to co-operative research work, and, also, to uphold the prestige of the Heating and Ventilating Society in the research program.

5. Under the new regulations governing the Committee on Research, a request has been received from the *Heating and Piping Contractors National Association* for a program of testing and rating of various types of radiation. Acting upon this request, the Committee on Heat Transmission has outlined a method of test procedure and estimated the approximate cost for the work. This report has been submitted to the *Heating and Piping Contractors National Association*, and as soon as approved by them, the necessary arrangements will be made for doing the work. A few requests have been received for minor tests which do not come under the scope of the Laboratory regulations. In all cases, these have been satisfactorily disposed of by explaining to the applicant the conditions under which certain tests may be made.

Executive Secretary for Researcch

One of the outstanding changes in the Laboratory organization has been the appointment by the Council of an Executive Secretary to the Committee on Research. The functions of the Secretary are to relieve the Chairman of many of the duties which cause an excessive demand on his time, to place the value of research before the public, to assist in raising funds for research projects in general, to further the interest of the Society in research and to insure the administrative continuity of the Committee.

A man well qualified from past experience and training, Thomas J. Duffield, was appointed February 1 to this position. It necessarily takes some time for a new man to become wholly familiar with all the activities of the Committee on Research and the possibilities connected therewith. It is expected that Mr. Duffield will be able to give a very good account of himself as time goes on, and in order that all may become better acquainted with him and his work, he will present a short report covering the financial aspects of the committee work.

Technical Advisory Committees—1930

Since the field of Heating and Ventilation covers a wide number of specialties, it is necessary that the Research Laboratory cover a diversified number of projects and carry on research which is of interest and necessity to the various branches of the profession. In order that the Laboratory may be of greater service and in the closest contact with the various interests, each of the major projects which are under investigation are under the general direction of the Technical Advisory Committees. The following are the Technical Advisory Committees which are at present active. New committees are under consideration and will be appointed as new projects are undertaken by the Laboratory.

Air Cleaning Devices: O. W. Armspach, *Chairman;* C. A. Booth, Albert Buenger, Philip Drinker, and H. C. Murphy.

Air Conditions and Their Relation to Health: W. H. Carrier, *Chairman;* A. C. Willard, Philip Drinker, Dr. E. V. Hill, W. A. Rowe, and C. P. Yaglou.

Atmospheric Dust and Smoke: A. S. Langsdorf, *Chairman;* Dr. E. V. Hill, H. C. Murphy, Dr. S. W. Wynne, and O. W. Armspach.

Garage Ventilation: E. K. Campbell, *Chairman;* A. R. Acheson, A. C. Davis, E. B. Langenberg, and W. C. Randall.

Heat Transmission: A. E. Stacey, *Chairman;* A. B. Algren, P. D. Close, A. P. Kratz, and H. J. Schweim.

Oil Burning Devices: L. E. Seeley, *Chairman;* P. E. Fansler, R. V. Frost, H. R. Linn, J. H. McIlvaine, and H. F. Tapp.

Pipe Sizes for Heating Systems: H. M. Hart, *Chairman;* S. E. Dibble, F. E. Giesecke, C. V. Haynes, and R. C. Morgan.

Projects Under Investigation at the Research Laboratory, Pittsburgh, and at the Various Co-operative Institutions

I. Air Conditions and Their Relation to Health

II. Heat Transmission
- (*a*) With reference to built-up wall construction (Univ. of Minn.).
- (*b*) Effect of aging on the conductivity of concrete (Pittsburgh).
- (*c*) Heat absorbed from Solar Radiation (Pittsburgh).
- (*d*) Use of the Nicolls Heat Flow Meter.

III. Infiltration of Air Through Walls
- (*a*) Tests to determine leakage through various types of walls (Univ. of Wisconsin).
- (*b*) A study of the "drift" of air across buildings (Univ. of Wis.).

IV. Pipe Sizes for Steam Heating Systems
- (*a*) Capacity of pipes for various parts of a hot water heating system (Texas Agricultural and Mechanical College).
- (*b*) Capacity of pipe for various parts of a steam heating system (by Research Laboratory at Carnegie Institute of Technology).
- (*c*) Study of the use of copper and brass pipe in steam and hot water heating (plans under way).

V. Air Cleaning Devices
A study of methods for determining the amount of dust in air.

VI. Radiation
(*a*) Plans under way for determining the heat output from various types of radiation (Pittsburgh).
(*b*) A study of heat distribution from different types of radiation.
(*c*) Determination of proper method of testing radiators (Purdue).

VII. Garage Ventilation
(*a*) A study of conditions at Washington University (by Dean Langsdorf).

VIII. Oil Burning Devices
(*a*) A study of the operation and method of test (Yale University, Prof. Seeley).

IX. Atmospheric Dust and Smoke
A study in co-operation with U. S. Weather Bureau and public health departments of various cities.

X. Measurement of Air Flow Through Registers and Grilles
(with Armour Institute, Prof. Davies).

XI. A Study of Thermal Properties of Different Species of Wood
(in co-operation with National Lumber Manufacturers Association).

Co-operative Agreements

The co-operative agreements and contracts are now in force with the following institutions:

Armour Institute of Technology
Association for Correlating Thermal Research
Carnegie Institute of Technology
Harvard University
National Lumber Manufacturers Association
Purdue University
Texas A. & M. College
University of Kentucky
University of Minnesota
University of Wisconsin
Washington University (St. Louis)
Yale University

Budget

The estimated budget for the year was $36,000. However, due to the fact that the office of Executive Secretary was created after the budget was made out some changes will be necessary.

The Laboratory is supported financially by 40 per cent of the dues from the members and by contributions from associations, manufacturers, and individuals who are interested in the work.

FIG. 1—PITTSBURGH EXPERIMENT STATION OF THE U. S. BUREAU OF MINES WHERE THE RESEARCH LABORATORY OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS IS LOCATED

Report of the the Research Director, June, 1930

By F. C. Houghten

Since the annual meeting of the Society, the Research Laboratory has continued work on the six investigations under way at the Laboratory in Pittsburgh and at the eight cooperating institutions. Five of these investigations were brought to a sufficient state of completion to warrant presentation of technical papers at this meeting as follows:

1. Surface Conductances as Affected by Air Velocity and Character of Surface, by F. B. Rowley, A. B. Algren and J. L. Blackshaw.
2. Capacity of Return Mains for Gravity and Vacuum Steam Heating Systems, by F. C. Houghten and Carl Gutberlet.
3. Loss of Head in Submerged Orifices, by F. E. Giesecke.
4. Air Infiltration Through Various Types of Wood Frame Building Construction, by G. L. Larson, D. W. Nelson, and C. Braatz.
5. Carbon Monoxide Concentration in Garages, by A. S. Langsdorf and R. R. Tucker.

In addition to the investigations resulting in reports presented at this meeting of the Society, the study of heat and moisture loss for men working, and also the study of oil burning devices at Yale University, have progressed sufficiently to warrant preparation of technical reports. However, these were not completed in time to be included in the summer meeting program.

PROBLEMS UNDER INVESTIGATION BY THE RESEARCH LABORATORY IN PITTSBURGH AND IN VARIOUS COOPERATING INSTITUTIONS

I. AIR CONDITIONS AND THEIR RELATION TO HEALTH

Technical Advisory Committee—W. H. Carrier, *Chairman*, A. C. Willard, E. V. Hill, W. A. Rowe, C. P. Yaglou.

Since the annual meeting of the Society, the Laboratory has continued the study of heat and moisture dissipated to the atmosphere from the bodies of men working at various rates in still

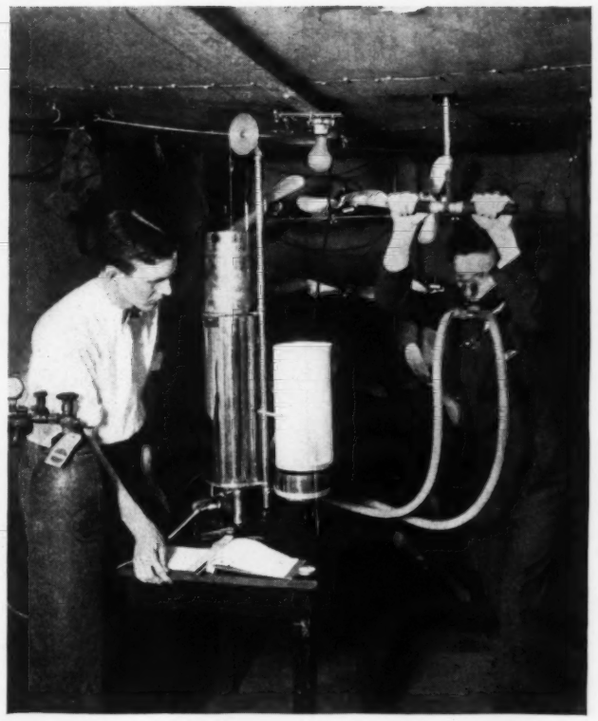


Fig. 2—Determining the Metabolic Rate of a Man Working in a Study of the Rate of Heat Production in, and Dissipation from, the Bodies of Working Men and the Effect of Atmospheric Conditions on the Differentiation of These Losses Between Sensible and Latent Heat Absorption. Mr. Teague of the Laboratory Staff Determining the Metabolic Rate of Mr. Hunter

and moving air and also the study of metabolic rates and heat and moisture dissipated from the bodies of children of school age in still air. The series of tests planned for the first mentioned investigation has been completed and a report prepared. Most of the work outlined on the study of heat dissipation from children of school age has been completed and a report of this subject will be available in the near future.

The Technical Advisory Committee on this subject in the past decided that the Laboratory should make a few check tests on the accuracy of the effective temperature lines within the comfort zone and the comfort temperature. These tests have not yet been made but will be as soon as the above studies are completed. The study of vital characteristics of the atmosphere is being continued by Harvard in cooperation with the Research Laboratory.

Mr. Carrier's committee has been very active in planning a comprehensive study of the whole subject of relation of atmospheric conditions to the health and comfort of man to be made in cooperation with the U. S. Public Health Service and other organizations interested in this general subject. A tentative plan for this work is under consideration and very satisfactory progress is being made. In connection with these plans a conference attended by Mr. Carrier, Chairman of the Technical Advisory Committee, Dr. Thompson of the U. S. Public Health Service, Mr. Houghten, Director of the Research Laboratory, and Mr. Duffield, Executive Secretary of the Research Committee, was held at the U. S. Public Health Service in Washington during February and another conference attended by the same persons and also Mr. Drinker of Harvard University, was held in Boston during March.

II. Heat Transmission

Technical Advisory Committee—A. E. Stacey, *Chairman*, P. D. Close, A. B. Algren, H. J. Schweim, A. P. Kratz.

1. *Heat Transmission Through Built Up Walls*—at the University of Minnesota.

Professor Rowley at the University of Minnesota is continuing the study of heat transmission through built-up walls in his guarded hot box. A large number of types of construction have been tested and the results have found their way into the publications of the Transactions and The Guide. This work is being continued.

2. *Conductivity of Homogeneous Building and Insulating Materials*—at the University of Minnesota.

The determination of fundamental coefficients of conductivity for various homogeneous building and insulating materials is

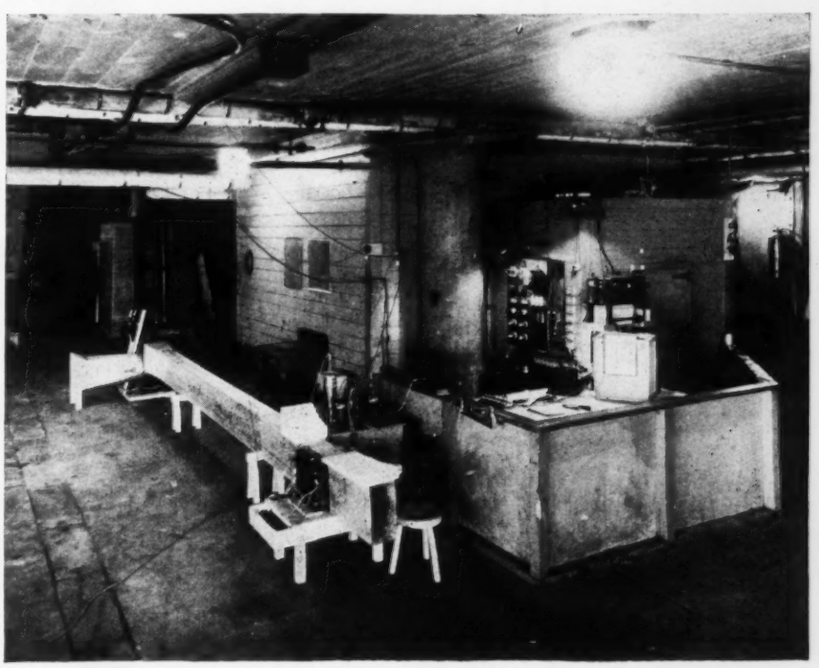


Fig. 3—Apparatus Used by Professor Rowley and His Assistants at the University of Minnesota for Measuring Surface Transmission Heat for Still and Moving Air

Fig. 4—Wall with Pitot Tubes in Place Attached to a Truck as Used to Determine the Wind Velocity Gradient Away from a Wall Whose Surface Is Parallel to the Direction of the Wind. Mr. McDermott of the Laboratory Staff

being continued by the guarded hot plate method at the University of Minnesota. A large number of materials the coefficients of which have been in doubt are being purchased on the open market and tested in order to build up a table of conductivity coefficients of materials on the market at the present time. By agreement with the Lumber Manufacturers Association a large number of samples of wood are being studied. It is hoped that this table will aid in the preparation of more extensive tables in The Guide.

3. *Study of Surface Coefficients for Various Types of Surfaces for Still and Moving Air*—at the University of Minnesota and Pittsburgh.

Professor Rowley is continuing the study of surface transmission coefficients for various types of surfaces, in the apparatus in his Laboratory designed for that purpose. Coefficients have been published for plain and painted wood, smooth and rough plaster, concrete, stucco, and glass surfaces. Data were also published showing the variation in these coefficients with mean temperature.

A similar study of surface transmission coefficients is being made at the Research Laboratory in Pittsburgh in an apparatus designed by Mr. Harding in cooperation with the Laboratory while he was Chairman of the Technical Advisory Committee on Heat Transmission in 1928 and Chairman of the Research Committee in 1929. The object of this study is not so much the determination of coefficients for use in practice as it is the study of factors influencing surface heat transfer. In this connection a study was made during the latter part of last year of wind velocity gradients near a surface for a wind blowing parallel to the surface.

Surface transmission coefficients for a painted sand coat finish were determined early this year in the apparatus designed for this purpose. Considerable difficulty was met with in the operation of the apparatus which together with the fact that the coefficient found for this surface was higher than had been used heretofore, resulted in lack of confidence in the findings, for two or three months, during which time a great many check tests and an analysis of the operation of the apparatus were made. Recently changes were made in the design of the apparatus after which additional tests were made on a painted, sanded surface and on a smooth, unpainted wood surface.

The change in the design of the apparatus resulted in much more satisfactory operation and in economy in time and the coefficients of the smooth wood surface were found to check very closely similar data by other investigators. Extensive data have been collected showing the air velocity gradients parallel to the surface and the temperature gradients away from it for the apparatus as designed with a 12x12 in. duct and also when duct was reduced in size to 6x12 in. With these data and the data previously collected by the Laboratory on the wind velocity gradient away from a wall it is hoped that important relationships may be worked out. This apparatus was designed with a view of later separating the total heat loss from the surface for given surface and velocity conditions into heat loss by radiation and convection.

4. *Effect of Aging on the Conductivity of Concrete*—at Pittsburgh.

This study is being continued and tests were made during the past six months showing that the present change in conductivity is slow and the study can probably be discontinued, after another year. Tests in the future probably need not be made oftener than once in three months. The present test sample of concrete has been studied for 3 years during the first two of which the conductivity changed very materially verifying the contention of many heating contractors that this is a very important factor in heating a concrete building during the first two seasons.

5. *Heat Absorption from Solar Radiation*—at Pittsburgh.

A paper was presented at the Annual Meeting giving the results of the Laboratory's study of absorption of solar radiation by a wall or roof surface and the effect which angle, color, and temperature of the surface has on such absorption. No plans are now perfected for continuation of the study. However, there appears to be some demand for additional determinations of the effect of solar radiation on heating problems. If additional

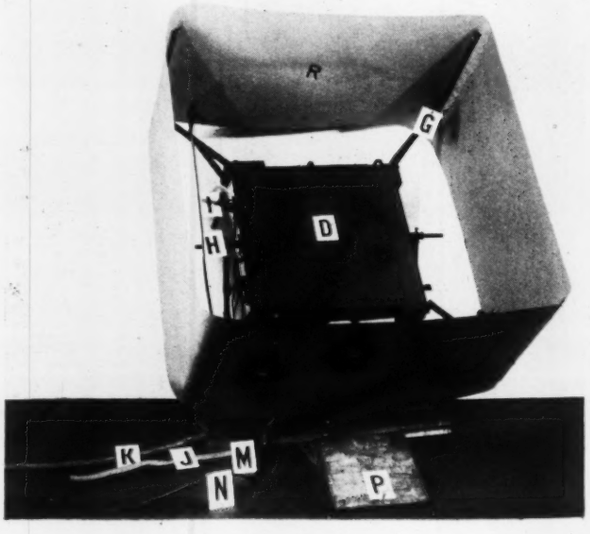


Fig. 5—Apparatus Used at the Laboratory in a Study of Absorption of Solar Radiation in Relation to Color and Character of the Surface, Its Angle with the Direction of the Sun's Rays, and the Effect of Varying Air Temperatures and an Intervening Plate of Glass

studies of this nature are to be continued plans should be developed in the near future, so that the work can be undertaken during the summer months.

6. *Nicholls Heat Flow Meter.*

The Laboratory has discontinued its studies of heat transmission through actual building construction under natural weather conditions with the heat flow meters. It is, however, encouraging the use of these instruments for such studies by others and at the present time has lent several of these instruments to the Mellon Institute for use in a study of heat transfer through various types of brick and hollow tile wall construction. Some help in the way of advice and direction for applying the meters and collecting and analyzing the data has been given with a view of assisting in the use of the meters and with a further view of establishing additional data on additional types of walls which may be helpful in the Laboratory's general study of heat transmission. Dr. Anderegg of Mellon Institute is in charge of these studies.

Last year Mr. Nicholls, in cooperation with the Laboratory, made seven new Nicholls Heat Flow Meters. The immediate object in making these meters was to supply the University of Illinois with two for use in their study of a radiator testing room. These two meters were turned over to the University of Illinois early this year. As a result of acquiring the additional five meters the Laboratory has some of these available for distribution to other scientific laboratories interested in research. The Laboratory's object in distributing these meters is two-fold: first, the encouragement of additional research on heat transmission, and second, the expansion of the use of the Nicholls Heat Flow Meter in heat transmission practice.

7. *Cooperation with the National Lumber Manufacturers Association.*

Professor Rowley and the Research Laboratory have perfected plans for cooperation with the *National Lumber Manufacturers Association* for the study of heat transmission through and conductivity coefficients of lumber and frame walls. This cooperation will greatly extend the activity of the Laboratory's cooperative program with Minnesota as regards heat transmission.

III. Infiltration

Technical Advisory Committee—G. L. Larson, *Chairman*, J. G. Shodron, M. S. Wunderlich, C. C. Schrader, J. E. Emswiler, D. S. Boyden.

Most of the work in this investigation is being carried on by Professor Larson at the University of Wisconsin in cooperation with this Laboratory. A study was recently completed of air leakage through various types of brick walls. These walls are being kept for possible future investigation. The major activity of this study is now on frame walls in cooperation with the *National Lumber Manufacturers Association*. This work is progressing very satisfactorily and a paper is presented at this meeting by Professor Larson on Infiltration Through Frame Walls.

Periodic tests are being continued on the brick veneer and hollow tile and stucco wall in the two pieces of infiltration apparatus in the Laboratory at Pittsburgh. Results of these two walls should be available for publication during the latter part of this year.

IV. Pipe Sizes for Heating Systems

Technical Advisory Committee—H. M. Hart, *Chairman*, F. E. Giesecke, R. C. Morgan, C. V. Haynes, S. E. Dibble.

1. *Capacity of Pipe for Various Parts of a Hot Water Heating System*—at the Agricultural and Mechanical College of Texas.

This study has been carried on by Professor Giesecke and his assistants at the Agricultural and Mechanical College of Texas for the past couple of years. A paper was recently given to the Society including a method of calculating pipe sizes for an entire hot water job. This method promises to give the designing engineer a consistent, straight-forward method of determining pipe sizes for hot water jobs similar to the method used for laying out steam heating systems. A great need has been felt for such a series of tables in the past and it is hoped that the results of the studies at Texas will fulfill this need. Plans are now being

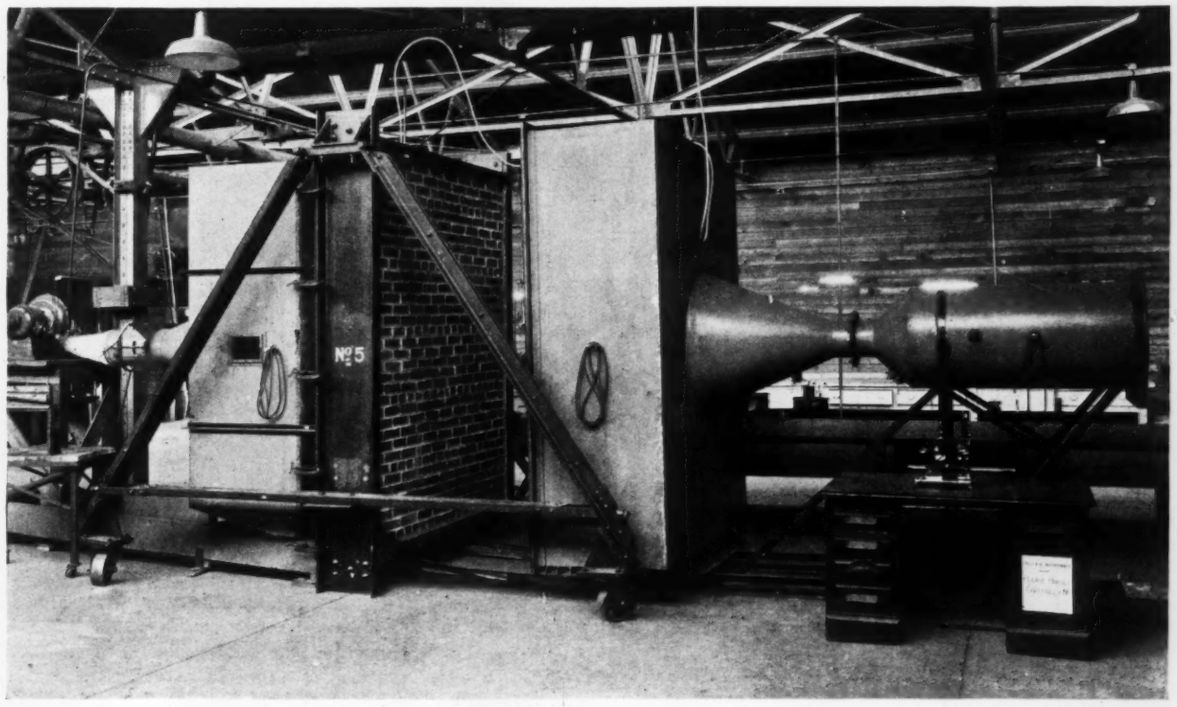


Fig. 6—Apparatus Used by Professor Larson and His Assistants at the University of Wisconsin in an Investigation of Air Leakage Through Various Types of Building Construction

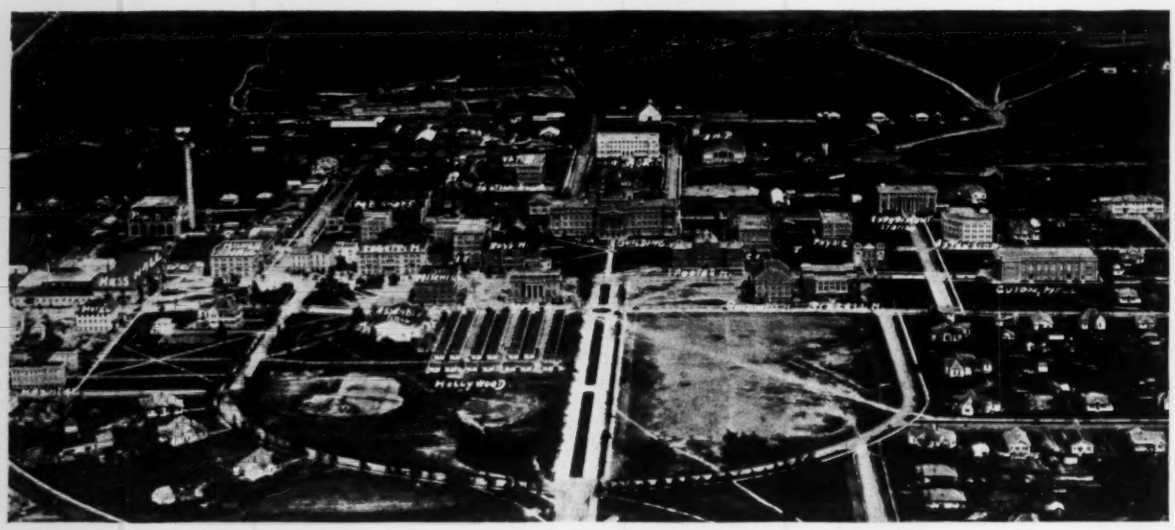


FIG. 7—BIRD'S-EYE VIEW OF THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS, WHERE PROFESSOR GIESECKE IS MAKING A STUDY OF CAPACITY OF PIPE FOR VARIOUS PARTS OF A HOT WATER HEATING SYSTEM

perfected for continuation or extension of the hot water pipe size study at Texas.

Professor Giesecke is now making a study of the use of orifices in hot water heating systems to insure proper distribution of heat to all radiators in a system. A paper on this subject is being presented at this meeting.

2. *Capacity of Pipe for Various Parts of a Steam Heating System*—by the Research Laboratory at the Carnegie Institute of Technology.

This general subject has been under investigation at the Laboratory in Pittsburgh or at Carnegie Institute of Technology since 1922 and a number of phases of the study have been completed, and the results have been published from time to time. During the past year the Laboratory has been working on the capacity of return risers and dry return mains for vacuum pump and gravity return systems. A large mass of data were collected during the heating season a year ago, which it was hoped would result in a conclusive paper on the subject. However, upon analyzing the data during the summer when steam and working conditions were not available, it was found that data were not sufficient to result in a conclusive paper on the subject and it was necessary to collect additional data under different conditions during the last heating season. As a result of the alterations in Professor Dibble's laboratory, it was necessary to design and build additional features to the laboratory set-up in order to give the additional results desired.

The main difficulties encountered in the study resulted from the fact that such return pipe have almost unlimited capacity provided the system is tight and no additional radiation is turned on from which air must be eliminated through the returns. Whereas, with the addition of comparatively small volumes of air into the system due to leakage in a vacuum pump, job, or due to elimination of air from cold radiators these capacities are greatly reduced. Any conclusions regarding the capacity of return pipe must be based upon the quantity of air handled as well as the radiation supplied. Collection of data was continued during the early part of the present year. A paper, "Capacity of Return Mains for Gravity and Vacuum Steam Heating Systems" was presented at this meeting. The study is being continued and it is hoped that a paper on the capacity of return risers may be presented to the Society next winter.

3. *Study of the Use of Copper and Brass Pipe in Steam and Hot Water Heating.*

Through the untiring efforts of S. R. Lewis and his interest in the research activities of the Society, plans are being developed for cooperation between the Laboratory and certain copper and brass pipe and tubing manufacturers whereby a study will be made of the comparative carrying capacity of such pipe or tubing in steam and hot water heating systems.

V. AIR CLEANING DEVICES

Technical Advisory Committee—O. W. Armspach, *Chairman,* Albert Buenger, H. C. Murphy, Philip Drinker, C. A. Booth.

This study has been carried on during the past few years by Professor Rowley at the University of Minnesota in cooperation with the Research Laboratory. Little progress was made during the past few months, however, due to concentration of effort on the heat transmission studies.

VI. RADIATION

Technical Advisory Committee—A. P. Kratz, *Chairman,* S. R. Lewis, R. S. Franklin, H. F. Hutzel, J. F. McIntire.

The subject of methods of determining the heat emission from various types of radiation has been the most active on the Laboratory's program during the past few months. The main reason for this activity is the desire on the part of the Heating and Piping Contractors National Association and others that the Laboratory make heat emission tests on a great many radiators, together with a further demand from other groups that the Laboratory make additional studies on the heating effects of radiators in different designs of rooms. The interest in this study has not yet crystallized, however, into a concrete plan.

VII. GARAGE VENTILATION

Technical Advisory Committee—E. K. Campbell, *Chairman,* E. B. Langenberg, W. C. Randall, A. C. Davis, A. R. Acheson.

The subject of garage ventilation was studied during the past winter by Dean Langsdorf of Washington University, St. Louis in cooperation with the Research Laboratory. The object of the study was to develop information concerning accumulations of CO, gasoline vapors, and other obnoxious gases or vapors in any part of a garage in sufficient concentration to constitute a hazard to health of workers, or a fire or explosive risk. Also to determine the relative effect of various methods and rates of supplying and exhausting air in eliminating these hazards. A number of disappointments were met with in the study during the past year because of the lack of cold weather in St. Louis requiring closed doors in garages. However, considerable data of interest were collected and a paper on the subject was presented by Dean Langsdorf at this meeting. Plans for this study during the next year are now being made by Mr. Campbell's

FIG. 8—SET-UP USED BY THE RESEARCH LABORATORY AT CARNEGIE INSTITUTE OF TECHNOLOGY IN A STUDY OF CAPACITY OF RETURN PIPING IN STEAM HEATING SYSTEMS

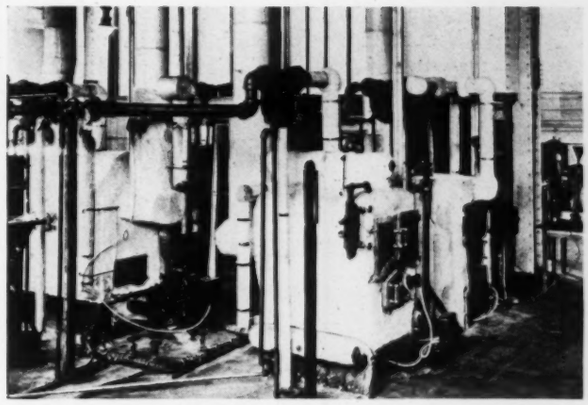


FIG. 9—LABORATORY SET-UP USED BY PROFESSOR SEELEY AT YALE UNIVERSITY IN A STUDY OF METHODS OF TESTING OIL BURNERS IN BOILERS AND FURNACES

Committee and it is probable that additional studies will be made next winter in a colder climate.

VIII. Oil Burning Devices

Technical Advisory Committee—L. E. Seeley, *Chairman*, H. F. Tapp, P. E. Fansler, H. R. Linn, J. H. McIlvain, R. V. Frost.

A study of operation of oil burners in heating systems and methods of testing oil burner-boiler and oil burner-furnace combinations is being made by Professor Seeley at Yale in cooperation with the Research Laboratory. This study has been under way for several months and valuable data are now being collected. As a result of these studies a short paper covering a very small phase of the work appeared in the May issue of the Journal and a progress report was given by Professor Seeley at the Chicago meeting of the *American Oil Burner Association.*

IX. Atmospheric Dust and Smoke

Technical Advisory Committee—A. S. Langsdorf, *Chairman*, E. V. Hill, H. C. Murphy, Dr. S. W. Wynne, O. W. Armspach.

This study has been dormant for the past few months following the completion of the collection of the first year's data by the U. S. Weather Bureau and the public health departments of the seven cities. Work is now being planned for a study to be made by Dean Langsdorf of Washington University in cooperation with the Research Laboratory.

X. Measurement of Air Flow Through Registers and Grilles

Technical Advisory Committee—S. R. Lewis, *Chairman*, J. J. Haines, John Aeberly, L. E. Davies.

This study has been under investigation by Professor Davies of Armour Institute in cooperation with the *Ventilating Contractors Employers Association of Chicago* and the Research Laboratory for the past year. A report on the study was made by Professor Davies last winter which gave data on methods of measuring air flow through certain grilles of rather simple construction. Air flow through ornamental grilles is now being studied.

Professor Rowley requested a brief progress report of the finances of the Research Laboratory, which was given by T. J. Duffield.

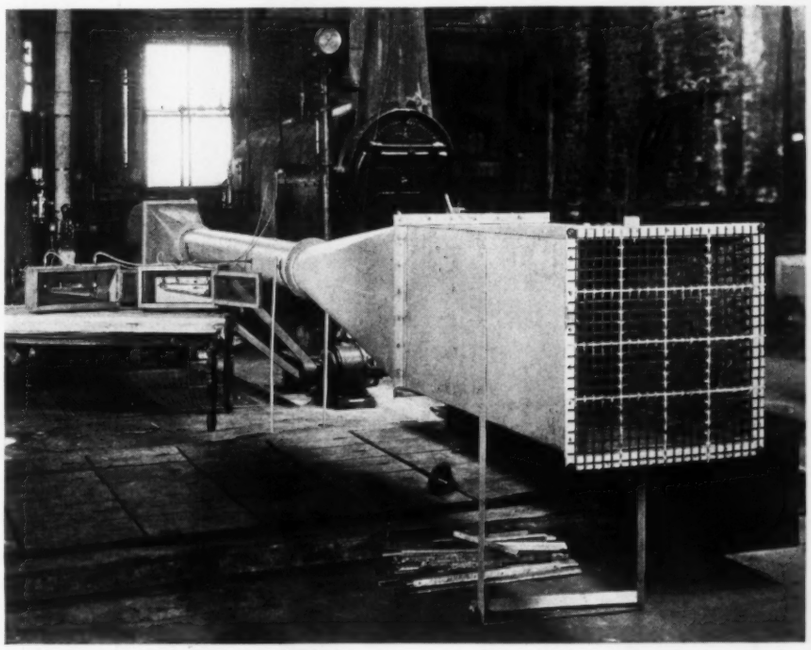


FIG. 10—SET-UP USED BY PROFESSOR DAVIES OF ARMOUR INSTITUTE IN COOPERATION WITH THE RESEARCH LABORATORY AND THE VENTILATING CONTRACTORS EMPLOYERS ASSOCIATION OF CHICAGO IN A STUDY OF METHODS OF MEASURING AIR FLOW THROUGH REGISTERS AND GRILLES

In a verbal report, T. J. Duffield, the executive secretary of the Committee on Research, said that a survey of available sources for funds indicated approximately $42,450 in sight at this time with the possibility of over $45,000, if some anticipated returns are made by organizations, who last year contributed $4,700, but who have made no commitment so far for 1930.

These funds would meet an estimated budget of approximately $40,000 which was an increase of $4,000 over the budget prepared by the Committee on Research, made necessary to meet the expense of travel and secretarial service required in the office of the executive secretary.

It was indicated that more money would be required to meet the program of additional work which has been visualized for the Research Laboratory.

Up to the present time pledges for $8,300 have been received, which is approximately $2,000 under last year's collections, but $3,850 had come in on funds previously pledged. To this might be added that the contribution from the Heating and Ventilating Exposition in Philadelphia which has been increased from the original $5,000 by $477.

So far the heating and ventilating industry has contributed $13,070 to support the research work which is very fair under existing conditions, but it is hoped that these figures can be raised considerably.

It is a matter of interest that ten organizations have made pledges for more than one year, so that some money can be counted on for next year's work.

The speaker also referred to the contributions made several years ago by the Illinois Chapter to go toward the Research Endowment Fund, so that now $600 is on hand.

In conclusion Mr. Duffield said, "Of course, it had been realized for a long time that we did not want to continue to solicit funds in industry if we could raise money to support our work in any other more dignified way. It was because of that feeling that impetus was given to this movement in the Illinois Chapter. We have counted on the possibility of soliciting funds among some of the philanthropic organizations who always want to aid in good work. I happen to have been associated at one time or another with two of them and I know that they would be sympathetic towards the sort of work we are doing in our Laboratory, but I felt that before we took our pleas to them, it might be a good idea to build up the Research Endowment Fund from within the Society.

"The methods of doing this must come up before the Committee on Research and the Council before anything definite is done, but you should bear in mind that we would like to build the fund up to dignified proportions so that we might then go to the philanthropic organizations and tell them that in addition to the great sum that the Society is contributing toward the support of our current program each year, we have also a Research Endowment Fund of sizable proportions from which we receive income, and we would like to have additions to it."

In commenting on the report, W. T. Jones, Boston, proposed a vote of thanks to C. F. Roth of the International Exposition Co. for the additional contribution to the research fund which resulted from the recent Heating and Ventilating Exposition in Philadelphia. The motion was seconded and unanimously carried.

E. C. Evans, Los Angeles, Cal., said that it was easy to "sell" the Society to engineers, and pointed out that some addition to our funds would result from the initiation fees and dues paid by recent applicants for membership, who would form the nucleus of a fine chapter on the Pacific Coast.

President Harding said that he had listened to many reports from chairmen of the Committee on Research, and expressed the belief that the present report was the best that had ever been given. He said he did not believe the membership of the Society fully appreciated the value of the research department. This is, he pointed out, the only engineering organization in the world that maintains its own research department, a committee on research or a research laboratory. When talking about it with other engineers, civil, mechanical and electrical, etc., they seem to be amazed that this organization maintains such a department. Research in reference to the vital characteristics of the air is of the utmost importance to this Society and some other organizations. In conclusion he said, "We delight in giving our renowned scientists praise for the discovery of the so-called structure of the atom and yet to a layman it appears strange that we do not know what are the vital characteristics of the air. To my mind this is the most important piece of research that the Society has before it. It may and will probably take years to finish and will require the cooperation of physicists and physicians. No other organization I believe, has arranged any research programme covering the subject. We are on our way. Philip Drinker at Harvard is now studying the ionization of the air. I haven't any doubt that we will find funds forthcoming to carry on the work from other scientific and engineering societies as well as philanthropic organizations."

Second Session—Wednesday, June 25—9:30 a. m.

After calling the meeting to order, President Harding introduced Prof. F. B. Rowley who gave an abstract of the paper, Surface Conductances as Affected by Air Velocity and Character of Surface, by F. B. Rowley, A. B. Algren and J. L. Blackshaw. This paper gave further results of the co-operative research work between the Society and the University of Minnesota, and was published in full in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, June 1930, p. 501.

A written discussion by Professors A. C. Willard and A. P. Kratz was presented by Professor Kratz and gave a comparison between the results of Professor Rowley's work and the results of some previous work done at the University of Illinois and reported in the Engineering Experiment Station Bulletin 102. It was indicated that there was satisfactory agreement and it was pointed out that for velocities below 15 mph. the agreement between the two series of investigations is quite satis-

factory and justifies confidence in the calculated heat transmission coefficients published in THE GUIDE.

D. R. Brewster, Memphis, Tenn., presented a written discussion and pointed out the clear cut relationship between the conductance of materials with a rough surface and those with a smooth surface, indicated in Fig. 22. The value of the data presented to the building industries is obvious, he stated, and may indicate that a succession of "dead air spaces" in wall or roof constructions may have a composite insulating value equal to, if not greater than much heavier and more solid constructions, particularly if infiltration is cared for.

R. E. Backstrom, Cloquet, Minn., compared several of the values with figures given in THE GUIDE, and said that with the comprehensive data on surface conductances and with other data previously reported by the authors on air spaces and various building insulating materials, it was now possible to accurately compute overall transmission coefficients for built-up sections, and further, that data are available for different mean temperatures which should not be overlooked in selecting proper values to be used for calculation.

F. C. Houghten, Pittsburgh, Pa., stated that at the Research Laboratory in Pittsburgh, work was being done on another phase of the subject of determining surface transmission coefficients. The results obtained in the few tests made at Pittsburgh bear out almost exactly the information given by Professor Rowley, and the Laboratory hopes to have something of value to report in the near future.

President Harding said that the Society has been working on heat transmission problems for a long time but the solution appears to be in sight if all results on record are correlated. Due to the difference in the points at which air velocity was measured in the University of Illinois tests and those made by Professor Rowley, a corresponding difference in results is apparent, but it seems likely that the results are comparable.

President Harding presented Professor A. P. Kratz of the University of Illinois, co-author with Professor A. C. Willard, of the paper, Wall Surface Temperatures. (Complete text of this paper appears in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, April 1930, p. 335.)

It was pointed out by Professor Kratz that temperature measurements have nearly always been made on models, but at the University of Illinois an opportunity was presented for measuring the surface temperatures of installations containing walls in actual service or under conditions where actual service could be closely approximated. It was the opinion of the authors that actual inside surface wall temperatures should receive further study, and the paper endeavors to point out a few factors relating to actual comfort conditions which exist in ordinary rooms.

Before proceeding with the discussion, President Harding said that the next paper, How Comfort Is Affected by Surface Temperatures and Insulation, by Paul D. Close, Technical Secretary of the Society, was in the nature of a discussion of the paper, and asked Mr. Close to read his paper. (Complete text of this paper will appear in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, Sept., 1930.)

Five written discussions were presented. The first was by President Harding, who said that this paper raised a point which has an important bearing on future research dealing with the comfort problem and forcibly calls attention to a fact frequently observed in house heating, that the occupants are not always comfortable in a 70 F room dry-bulb temperature in cold weather. This is often attributed to the very low relative humidity, perhaps erroneously. The layman naturally interprets the condition of the air as to temperature and relative humidity within the "comfort zone" of the A. S. H. V. E. Comfort Chart, to mean that the conditions shown will produce a state of well-being or quiet enjoyment called comfort. The engineer interprets the chart values to mean equal degree of comfort on any effective temperature line. It would appear, however, that either interpretation may be upset by changes in the wall surface temperature to values quite different from the surface temperatures maintained during the tests when the Comfort Chart values were determined.

John Howatt, Chicago, Ill., in a written discussion, related that where heat was intermittent as in school buildings and churches, it is often necessary to carry the room temperature at a designated point for some time before occupancy, if people are to be comfortable, and the length of time required to warm walls, furniture, etc., depends upon materials and their volume. A rule in Chicago schools requires maintaining room air temperatures for thirty minutes before the opening of classes.

Prof. F. B. Rowley, Minneapolis, Minn., pointed out that for a given wall the inside surface temperature will drop with the outside air temperature and wind velocity. The greater this drop, the greater the temperature rise of the inside air must be to counteract radiation effects. The amount of the inside surface drop will depend not only upon the outside weather conditions, but also upon the construction of the wall, its resistance to heat transmission and air infiltration. If these resistances are high, the inside surface temperature will be more nearly equal to the inside air temperature and the final effect would be a lower required air temperature in the room.

It was Professor Rowley's opinion that the paper opens up a phase of heat transmission which should have more extended investigation in order that the heating engineer may be able to predict the true conditions which must be met in any heating installation.

Prof. J. D. Hoffman, Lafayette, Ind., stated that the authors offered a simple adaptation of the temperature drop curves to the rating of building walls, and demonstrated in a most practical and convincing way why various types of construction will give certain kinds of results under any given set of weather conditions.

Prof. C. H. B. Hotchkiss, Lafayette, Ind., gave a written analysis of the paper, and complimented the authors on the fact that the data given from field studies were the first that could be checked with a similar laboratory set-up and analysis of variable factors made.

President Harding called for a full discussion of this subject saying that if it is assumed that a radiation loss of the body to a cold wall surface affects comfort, four items were open to discussion.

W. H. Carrier, Newark, N. J., complimented the authors upon the manner of presentation, and said that

it was the best example that he could recall of the presentation of research data.

In introducing his discussion, Mr. Carrier spoke about man's environment, and said that he was born for the conditions surrounding him, and said that until recently fire was the only thing desired, but later developments have acknowledged the necessity for humidity, and this paper brings another factor into the discussion. A very definite challenge to the exactness of the Comfort Chart has been given, and while much has been said on the question of temperature having one effect and radiation from windows and walls another effect, nothing has been said about the fact that while walls, windows and floors may be cold, the ceiling may be hot and this will have a counteracting effect. While a person may not be near the ceiling, radiation may have an effect.

It is necessary to define the meaning of the term "temperature of a room," he believed and pointed out that it is possible for a person to be too hot on one side and too cold on the other at the same time, and for that reason it is necessary to have the temperature of walls, air, floor, ceiling, etc., about the same. A thermometer therefore records the average condition and is affected in about the same way as the body. A wet and dry bulb thermometer, under any variable condition, will give exactly the results obtained in the Laboratory where air, walls and ceiling are purposely kept at a uniform temperature.

Previous speakers have talked about room temperature, assuming that it is the temperature of the air. Actually, room temperature is a composite effect of heat flow inward and outward to that object from all sources. In order to obtain the greatest comfort, it is necessary to have a fairly uniform room temperature all around.

F. C. Houghten, Pittsburgh, stated that the paper gives additional data on the two major projects, namely, heat transmission and human comfort. It gives interesting ratios of outside temperature difference between the wall and air and the inside temperature difference. It might be pointed out that when plans for the comfort studies were prepared, the Committee gave consideration to various factors affecting comfort, including radiation and the Laboratory took into consideration the approximate effect of radiation which was believed to be relatively unimportant. The fact that a matter, which was considered insignificant 10 years ago, now comes up as a major factor, indicates the measure of progress being made.

Thornton Lewis, Philadelphia, Pa., said that it was apparent to all that the results of the discussion would develop some very interesting data for the use of heating and ventilating engineers. He described a visit that he made last summer to the Waterford Research Station in England, where investigations are conducted by the British Government, relating to heat. English engineers are attempting to heat almost entirely by radiation and to minimize any heating effect from convection. Recognizing the fact that in heating by radiation a thermometer or thermocouple would undoubtedly not register the true effect of the human body, they have built a copper cylinder with a surface equaling the surface of the human body, and measure the effect of radiation on this cylinder.

P. J. Marschall, Chicago, Ill., said that engineers are acquainted with the fact that a dry bulb thermometer does not give a true index of comfort conditions, but the paper gives information which may account for the fact that people who often contract colds when they lie down in the average living room, sometimes have two or three exposed walls and a cold floor, thereby exposing themselves to far different conditions than the 70 deg. temperature maintained at the breathing line.

J. C. Miles, Cleveland, explained that the paper was of great interest to practical men, and said that he hoped the authors would investigate the effect of conditions in rooms with inside air movement.

F. D. Mensing, Philadelphia, contrasted the construction and equipment of a house and the clothing of the occupants 50 years ago and under present conditions, and pointed out that women, without knowing it, are the best heating and ventilating engineers. He cited an experience in an automobile factory building and told how the temperature of machinery affected production. The job of the heating engineer, he said, is to produce a condition in occupied dwellings or factories which does not permit the occupant to be conscious of temperature.

Professor Kratz, in concluding the discussion, said that it had not been the authors' intention to go into an elaborate discussion affecting all factors of human comfort, but attention had been concentrated upon just one factor, the temperature at the inside surface of a wall. It is impossible to answer all of the discussion given here, and while it is known that the problem is complex, the ultimate solution may be readily worked out, but all of the factors mentioned should receive consideration, in his opinion.

Third Session—Thursday, June 26—9:30 a. m.

After opening the session, President Harding announced that the first item of business would be the report of the Technical Advisory Committee on Oil Burning Devices by L. E. Seeley, and this report was given by Prof. F. B. Rowley, chairman of the Committee on Research.

Report of the Committee on Oil Burning Devices By L. E. Seeley, Chairman

The chairman wishes to report that since the last meeting of the Society at Philadelphia in January, 1930, much laboratory testing has been done. A test procedure was developed comprising seven types of tests for each combination of boiler and oil burner. This was all explained in a progress report made on April 11 at the meeting of the *American Oil Burner Association* in Chicago. This report was later published in the May issue of the Society's Journal. Four sets of the tests being run were included in the report by way of example.

Since that time more testing of the same nature has been done and the present program is about 60 per cent completed. The work will have to cease during the summer and be resumed in the fall. It is expected that this particular project will reveal operating characteristics of various types of oil burners and boilers.

Incidental to the program of testing is the matter of conducting a test, making measurements, etc. This will eventually call for a test code suitable for a combination of an oil burner and a heating boiler. Considerable work has already been done in this direction and it is the hope of the chairman that the Society will

wish to have such a code. The value of the present work being done by the Committee besides all work of this general nature will be enhanced if a standard test code is approved.

In the absence of H. M. Hart, Chicago, chairman of the Technical Advisory Committee on Pipe Sizes, F. C. Houghten, Director of the Research Laboratory, gave the following progress report.

Report of Committee on Pipe Sizes
By Harry M. Hart, Chairman

The Research Laboratory has been making a study of pipe sizes for steam and hot water heating systems for the past several years. The work on capacity of pipe for various parts of a steam heating system has been carried on at the Laboratory in Pittsburgh or by the Laboratory staff at the Carnegie Institute of Technology.

From time to time progress on various phases of this study has been presented to the Society, and the results have found their way into the development of the Steam Heating Pipe Size Chapter of the Guide, so that this Chapter of the Guide today, is perhaps, more completely based upon the findings of the Laboratory than any other.

The Laboratory has covered, so far, all phases of the work dealing with the supply side of the system and is now studying return pipe sizes for steam heating systems.

At this time there is being presented a paper resulting from the study of capacities of dry return mains and within the next few months the Laboratory hopes to present its findings on the capacity of return risers which will complete all phases of the study originally outlined.

The Laboratory's work on capacity of pipe for hot water heating systems is being carried on by Professor Giesecke at the Agricultural and Mechanical College of Texas in co-operation with the Laboratory. Satisfactory progress has been made in the development of practical and usable tables for laying out hot water heating systems. However, it is not felt that the ultimate success to be desired in this direction has been attained. In continuing this study Professor Giesecke is now presenting a paper on the resistance of flow through orifices and the application of such orifices to the proper proportioning of a system.

The first technical paper, Capacity of Return Mains for Gravity and Vacuum Steam Heating Systems by F. C. Houghten and Carl Gutberlet, was given in abstract by Mr. Houghten. (The complete text of this paper is published in A. S. H. V. E. Journal Section, Heating, Piping and Air Conditioning, August 1930, page 687.)

A brief written discussion by C. A. Thinn, Chicago, was presented by P. D. Close. Mr. Thinn expressed the hope that the research work could continue and expressed the opinion that pipe sizes generally are larger than necessary and could be reduced without interfering with the operation.

The next paper, developed through co-operative research between the Society and the Texas A. & M. College was entitled Loss of Head in Submerged Orifices, and was presented by the author, Prof. F. E. Giesecke. Professor Giesecke indicated that the paper was in the nature of a progress report and that further studies were being carried on which no doubt would bring out valuable information for heating engineers.

A written discussion from F. A. Nagler, Iowa City, Iowa, explained that the proper procedure for computing coefficients of discharge, was to add the velocity head of the water in the pipe to the head loss through the orifice, thus securing the velocity head corresponding to the speed of flow through the orifice.

A. W. Luck, Reading, Pa., said that in a study of hot water heating during the past 40 years, one of the greatest difficulties was the failure of designers to balance their systems. After describing some of the practical aspects of installations, Mr. Luck said that the charts presented by Prof. Giesecke would be very helpful to the men responsible for the design and installation of hot water systems. In concluding the discussion, Mr. Luck suggested some research to determine the proper height of a riser to circulate water at points below the supply mains or the heater.

The concluding paper of the session, Air Infiltration through Various Types of Wood Frame Construction by G. L. Larson, D. W. Nelson and C. Braatz, reported the results of research from co-operative work between the Society and the University of Wisconsin. (The full text of the paper was published in A. S. H. V. E. Journal Section, Heating, Piping and Air Conditioning, June 1930, p. 509.)

The presentation of the paper was made by Mr. Nelson and represented the final report on the work carried on during the past three years in the Laboratory at the University of Wisconsin.

A written discussion presented by Professor Kratz of the University of Illinois, Urbana, pointed out that the major part of air leakage results from faulty construction and that this could be reduced to a negligible amount. D. M. Brewster, Memphis, Tenn., directed attention to a study of building papers made by the U. S. Bureau of Standards, which bears out the results obtained by Professor Larson.

Two interesting features of the morning session, were the presentation of Dr. Max Toltz, St. Paul, introduced by Prof. Rowley, who gave a brief talk on the work of the American Engineering Council.

The next speaker was Julien Flegenheimer, the architect for the League of Nations, who spoke to the members in French and this was translated by T. J. Duffield.

Fourth Session—Friday, June 27, 9:30 a. m.

The final session of the Semi-Annual Meeting 1930 was opened by President Harding and after an opportunity had been given for a continued discussion of Professor arson's paper presented on Thursday, W. H. Carrier, N wark, N. J., was introduced and summarized the paper, The Application of Air Conditioning to Premature Nurseries in Hospitals, prepared by C. P. Yaglou, Philip Drinker and K. D. Blackfan. (The full text of this paper was published in A. S. H. V. E. Journal Section, Heating, Piping and Air Conditioning, July 1930, p. 605.

In opening the discussion, President Harding stated that this unusual paper was the first of its kind ever presented before an engineering organization.

F. C. Houghten said that this paper marked the beginning of a series of studies which would determine the part of air conditioning in the treatment of many human ills, and he told of some experimental work conducted by physicians of the University of Pittsburgh in

the treatment of diseases that had been considered practically incurable.

T. J. Duffield pointed out that the paper gave four criteria by which an improvement in health might be judged when such sensitive bodies were exposed to known air conditions.

H. Gille, Stockholm, Sweden, said that the Society's comfort charts are being used for air conditioning in Sweden and cited some experimental work that had been done in the treatment of fever.

E. C. Evans, Los Angeles, suggested continued additional research in cooperation with medical authorities to aid people with respiratory ailments.

A. S. Langsdorf, St. Louis, said that much work had been done by physicians of the General Electric Co. in the production of artificial fevers and also mentioned some work in the Washington University, St. Louis, where the work of medical faculty members had been assisted by the Engineering Department in measuring high body temperatures.

The report of the Committee on Garage Ventilation was given by E. K. Campbell, Chairman.

The concluding paper on the program, Carbon Monoxide Concentration in Garages, by A. S. Langsdorf and R. R. Tucker was presented by Dean Langsdorf. (The full text of the paper appears in the A. S. H. V. E. Journal Section, HEATING, PIPING AND AIR CONDITIONING, August 1930, p. 695.)

In commenting on the results of the carbon monoxide investigations, E. K. Campbell, Kansas City emphasized the necessity of continuing experimental work in colder climates and suggested that further work might be done in Boston.

Mr. Campbell read a letter from A. C. Davis, New York, whose connection with the construction and operation of the Holland Tunnel between New York and New Jersey is well known. He described a method of taking air samples and described the movement of carbon monoxide and suggested that in future work air samples be taken at several heights in a garage.

A. P. Kratz, Urbana, said that the garage problem merited serious consideration and observed that the concentration of CO reported was too high for continuous exposure.

At the conclusion of the technical program, President Harding introduced M. W. Eagan, Pittsburgh, representing the Chamber of Commerce, who extended a cordial invitation to the members to come to Pittsburgh in January 1931, for the 37th Annual Meeting of the Society which is to be held at the William Penn Hotel. He described some of the attractions at Pittsburgh and outlined some of the entertainment possibilities.

Report of Nominating Committee
By G. L. Larson, Chairman

A report of the Nominating Committee was given by Professor Larson, Chairman, and the nominees to be voted on at the annual election are as follows:

President, W. H. Carrier, Newark, N. J.

1st Vice-President, F. B. Rowley, Minneapolis, Minn.

2nd Vice-President, W. T. Jones, Boston, Mass.

Treasurer, F. D. Mensing, Philadelphia, Pa.

Members of Council (For 3 year term): Roswell Farnham, Buffalo, N. Y., E. Holt Gurney, Toronto, Ont., E. K. Campbell, Kansas City, Mo., E. O. Eastwood, Seattle, Wash., D. S. Boyden, Boston (for unexpired term of Alfred Kellogg, resigned).

W. T. Jones, Boston, said that the members had enjoyed a wonderful meeting as the guests of the Minnesota Chapter and he proposed the following resolutions for consideration:

Resolved, that it is the sense of this meeting that the Committees representing the Minnesota Chapter handling registration, reception, hotel accommodations and entertainment for this Summer Meeting, have anticipated our every want and that we feel highly repaid for making this trip to their beautiful cities.

Resolved, that we extend to the Hostesses of the Minnesota Chapter our sense of appreciation for the graceful and bountiful manner in which our ladies have been entertained.

Resolved, that we extend to the Management of the Curtis Hotel our thanks and appreciation of the excellent service rendered and the pleasant accommodations they have provided for our comfort during our stay in the Twin Cities.

Resolved, that we extend our appreciation for the splendid cooperation received from the technical and daily press in connection with this meeting just terminated.

Resolved, that we express our appreciation to the Chicago, Milwaukee, St. Paul and Pacific Railroad for the wonderful accommodations provided on the Pioneer Limited for our trip from Chicago and for the excellent repasts provided under the masterful direction of George Rector.

President Harding inquired if there was any unfinished business or new business before adjourning the meeting.

Members Find

Minneapolis Meeting Delightful

POINTING THE WAY TO GOOD TIMES IN MINNEAPOLIS

MEMBERS of the Society found Minneapolis delightfully cool and pleasant for the 36th Semi-Annual meeting during the four days, June 24 to 27, when much of the country was suffering from the heat.

The arrangements for the entertainment of everyone who attended the meeting at the Curtis Hotel had been well worked out in advance under the direction of Albert Buenger and his aides, who handled the reception of guests, transportation, entertainment, publicity, finances, sports and the special ladies entertainment.

With a registration in excess of 300 a great responsibility was placed upon the various committees and the smooth handling of every detail was evidence of the splendid organization and cooperation of the Minnesota Chapter members.

From the time that Messrs. Buenger, Jones and Rowley boarded the A. S. H. V. E. Special at St. Paul, until the climax event of the meeting, the banquet, on Thursday evening, nothing was overlooked that would add to the pleasure of visiting members and guests.

An innovation for Society meetings was the appearance each morning of a daily news bulletin which carried announcements and special notices as well as items of interest about visiting and local members. Joe Blackshaw was editor, reporter and printer's devil of this entertaining "newspaper."

Evidence of the preparations for the meeting was noticed by members as soon as they reached Chicago, as headquarters had been established for those traveling to Minneapolis through the cooperation of Pres. H. G. Thomas of the Illinois Chapter.

Promptly at 6:35 P. M. on Monday evening, June 23, the A. S. H. V. E. Pioneer Limited left Union Station, Chicago, via the Milwaukee Road with a group of 80 members aboard.

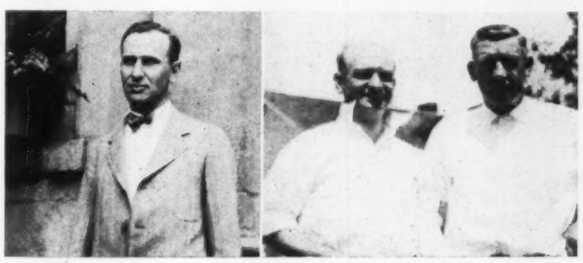
A special dinner prepared under the direction of George Rector was served and Mr. Rector made the trip to Minneapolis on this special.

On Tuesday morning incoming guests were met at the railroad station in Minneapolis by W. F. Uhl and his Transportation Committee, who had provided automobiles to carry the visitors to the Curtis Hotel.

Registration was held in the lobby of the Curtis and as each member registered he was provided with the necessary badge, program and a special map of the Twin Cities, which carried Entertainment Specifications and marked the high-ways and by-ways leading to good times during the Summer Meeting.

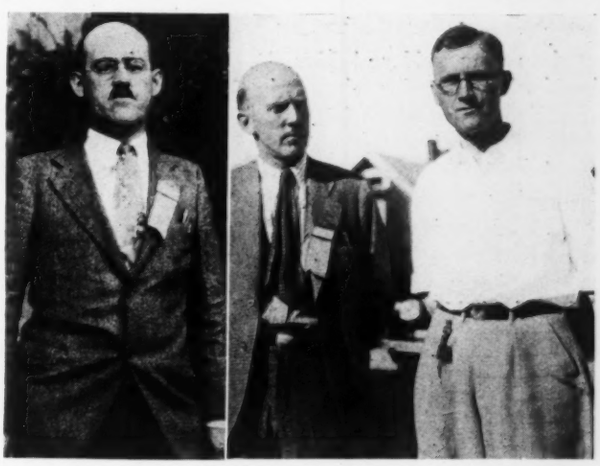
During the various trips around the Twin Cities on Tuesday and to the various golf and country clubs, special road signs were in evidence marking the proper route for the A. S. H. V. E. official cars.

Before noon on Tuesday the ladies were taken to the

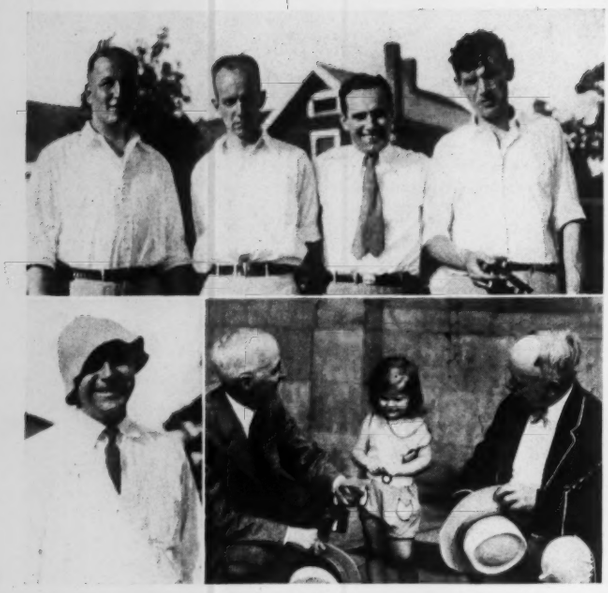


ALBERT BUENGER, ST. PAUL, CHAIRMAN, GENERAL ARRANGEMENTS COMMITTEE, N. W. CALVERT, CHICAGO, AND D. S. BOYDEN, BOSTON

TOP ROW—F. A. GAYLORD, CHICAGO; C. V. HAYNES, PHILADELPHIA; W. H. CARRIER; A. J. HUCH. BOTTOM ROW—MRS. SPOFFORTH; MRS. F. B. ROWLEY; MRS. A. BUENGER; MRS. M. H. BJERKEN, MINNEAPOLIS; MRS. MILLER; MRS. E. SZEKELY; MRS. W. H. CARRIER



E. A. JONES, ST. PAUL, PRESIDENT, MINNESOTA CHAPTER, D. M. FORFAR AND V. L. LARSON, MINNEAPOLIS



TOP ROW—R. E. MOORE, CARL F. HAYDEN, FRANK C. KEISNER, BEN BROS. BOTTOM ROW—L. G. WYNN, JOHN F. HALE, BEVERLY ANN NORMAN, DEAN F. PAUL ANDERSON

Minikadha Club where luncheon was served, and later a sight-seeing bus took them to the various points of interest in Minneapolis and St. Paul. The men, as a part of the sight-seeing trip through the Twin Cities, stopped to inspect the plant of the Minneapolis-Honeywell Co. and the Engineering Laboratories of the University of Minnesota where cooperative research with the Society was in progress.

On Tuesday evening at the Curtis Hotel, while the Council held its regular meeting, an informal reception and buffet supper was enjoyed in the ball room. During the evening motion pictures taken at previous Society meetings were shown, after which dancing was enjoyed until midnight.

During the Council meeting approval of a charter for a new chapter of the Society in Southern California was voted, which was particularly gratifying to two members in attendance, E. C. Evans and R. L. Gifford, who made the trip from the West coast.

The ladies spent Wednesday morning shopping in Minneapolis stores and in the afternoon played bridge at the Minneapolis Automobile Club. Some of the ladies elected to play golf and Mrs. D. E. French and Mrs. Schernbeck were prize winners in this event.

Nearby the men participated in a golf tournament for the Research Cup under the direction of H. J. Sperzel, and the successful golfer was F. A. Kitchen.

Following Mr. Kitchen, the prize winners were W. J. Mauer, Chicago; C. W. Presdee, New York; C. V. Haynes, Philadelphia; John Howatt, Chicago; R. E. Moore, Chicago, and W. H. Carrier, Newark, N. J.

After the bridge and golf scores had been turned in, a group of 175 sat down to dinner at the Minneapolis Automobile Club and during the dinner were entertained by two famous radio artists, Gale Wood and Bob Gehn.

The ladies who were rewarded for their bridge playing were: Mrs. Natkin, Kansas City; Mrs. Hanauer, Kansas City; Mrs. Hasey, Minneapolis; Mrs. Uhl, Minneapolis; Mrs. Huch, Minneapolis; Mrs. Martenis, Minneapolis; Mrs. Gordon, Minneapolis; Mrs. Monroe, Chicago; Mrs. Shrock, La Porte, Ind.; Mrs. Shipley, Minneapolis; Mrs. Hill, Minneapolis; Mrs. Roth, New York; Mrs. Heagler, St. Paul.

On Thursday after the Technical Session the members were taken to the Minnetonka Club where luncheon was served and a Kickers Handicap tournament was played during the afternoon. Diversions for those who did not play golf were provided at the Club and many played bridge or found amusement in other ways.

In the Kicker's handicap tournament, prize winners were: R. F. Connell, Detroit; L. J. Pitcher, Chicago; A. M. Wagner, Minneapolis; D. S. Boyden, Boston, and W. H. Bjerken, Minneapolis.

Not far away at Old Orchard on the banks of Lake Minnetonka the ladies enjoyed a picnic and tea during the afternoon.

On Thursday evening the big social event of the meeting, the Semi-Annual Banquet and Dance, was held in the ballroom of the Curtis Hotel.

Dean Anderson, past-president of the Society, was toastmaster, and the remarks of the speakers were most enjoyable. E. A. Jones, president of the Minnesota Chapter, expressed the pleasure of the Minnesota Chapter that so many members had attended the meeting, and Pres. L. A. Harding made some characteristic brief, but amusing observations, after which Albert Buenger, general chairman of the Arrangements Committee, was introduced and presented a gift of the Minnesota Chapter to Mrs. F. B. Rowley, chairman of the Ladies Committee.

The presentation of bridge and golf prizes to the winners of various games and tournaments was handled by D. M. Forfar.

A surprise award for continuous and consistent golf rivalry between W. H. Carrier and C. V. Haynes of Philadelphia was made to C. V. Haynes. Unknown to him a cup had been offered for competition between Mr. Carrier and himself, and Mr. Haynes found that he was the proud possessor of a cup similar to the one that hung by the old fashioned well.

The floor was cleared for dancing and Dick Long

TOP ROW—W. F. UHL, G. S. BEAN, C. E. BRONSON, H. J. SPERZEL. BOTTOM ROW—MRS. SHOCK, MRS. E. C. EVANS, MRS. JOHN F. HALE, MRS. D. E. FRENCH

and his famous orchestra kept the members and their partners stepping until 1 A. M.

On the final day of the meeting the ladies were entertained at hostesses luncheons in the homes of Mrs. Harry Gerrish and Mrs. S. C. Shipley.

Everyone who attended the Minneapolis meeting expressed the opinion that they were more than repaid for their trip to Minneapolis and paid full tribute to the hard work that had been done by their hosts, who had so bountifully provided for their pleasure and enjoyment.

Walter Klie Heads Heating and Piping Contractors

The deliberations of the *Heating and Piping Contractors National Association* at its 41st Annual Meeting, June 16 to 19, 1930, at the Hotel New Yorker, New York City, brought forth many interesting developments, particularly along trade promotion lines.

An unusual feature was the re-election of Walter Klie, Cleveland, for his third term as president, and he is receiving the congratulations of his fellow members in the Society.

The resignation of H. B. Gombers as Secretary, and his appointment as Secretary-Emeritus, was announced. Mr. Gombers, also a member of this Society, was paid fitting tribute for his 33 years of faithful service as secretary of the association. Joseph C. Fitts, who has been assistant secretary of the association for a number of years, will succeed Mr. Gombers.

The officers elected in addition to Messrs. Klie and Fitts were: Raymond L. Spitzley, Detroit, Vice-President; Robert D. Williams, New York, Treasurer; Joseph E. McGinness and Herbert Snow, Directors. Mr. Snow was elected to serve the unexpired term of Vice-President Howard, who resigned.

After an address of welcome at the opening session on June 16, 1930, several past-presidents of the association, P. Gormley, J. T. Bradley, J. E. Rutzler, N. L. Danforth, F. A. Merrill and H. M. Hart, were introduced.

In his address, Walter Klie discussed at some length the present business recession and pointed out ways and means of stimulating contract work.

President Klie's address was followed by the appointment of various convention committees, after which J. C. Howell delivered an address entitled What Is Ahead of the Heating and Piping Contractor?

The report of the National Headquarters was given at the morning session, June 17, 1930. In his report, Secretary H. B. Gombers stated that the increasing activities of the association made it necessary to enlarge the size of the headquarter staff, and to departmentalize the work of the headquarter's office. He spoke particularly of the creation of the Educational Department.

In the report of Assistant Secretary J. C. Fitts, details were presented of the work of the Standing Committee on Trade Promotion under the chairmanship of H. A. Snow of Boston.

Edward D. Byrd, field representative, presented a report concerning his activities, after which S. L. Land, recently appointed director of the Educational Department, outlined the program of this department, which includes administrative and general promotional service, and business management service.

The report of the Membership Committee, submitted by R. L. Spitzley, Chairman, indicated that the largest membership increase took place in New York State, which showed a gain of 40 per cent during the year.

G. M. Getschow, Chairman of the Sub-Committee on Boiler Output, was ill at the time of the convention and the report of his committee was read by H. M. Hart.

R. S. Franklin, Chairman of the Standards Committee, presented a copy of the new Engineering Standards, which have been considerably enlarged. Incidentally, the new book includes the heat transmission coefficients developed by the A. S. H. V. E. and published in The Guide.

At the session on June 18, 1930, the report of the Committee on Trade Promotion was presented. This report included that of a joint committee on trade practice rules of the *Heating and Piping Contractors National Association* and the *National Association of Master Plumbers*. An outline of four principles of credit policy was proposed by the Trade Promotion Committee, and a survey of the heating industry was submitted by Joseph C. Fitts.

The manufacturers and wholesalers of plumbing and heating material have prepared and established trade practice rules under the Federal Trade Commission, and have organized as the *National Plumbing and Heating Institute*.

G. B. Richmond, Secretary of the *Heating and Piping Contractors Memphis Association*, delivered a talk on Selling, Surveying and Heating for the Architect and Engineer, after which Trade Promotion in the Heating Industry was discussed by H. J. Buckley.

The Committee on Welding met at a luncheon on June 18, and J. H. Zink, Chairman of this committee, who presided at the luncheon, stated that ½-in. pipe can be welded as readily and as economically as 12-in. pipe, but exploded the common fallacy that small pipe can be butt-welded.

Plans for the future activities of the Association for Correlating Thermal Research were discussed at one of the noonday sessions of the convention. The reports of the various convention committees were presented at the morning session on June 19, 1930.

It was approved that an investigation be made of several terms over which there has been some confusion. These include "certified heat," "gold bond heat," and "guaranteed heating." The Trade Promotion Committee will cooperate with manufacturers to eliminate as far as possible such confusion.

Specifications presented by the Sub-Committee on Welding were approved. Trade Practice Rules submitted by the joint committee of the association and the National Association of Master Plumbers were approved and a resolution passed to the effect that a committee be appointed to work with the National Association of Master Plumbers to petition the Federal Trade Commission to hold a hearing on these rules.

Discussion on the question of moving the national headquarters from New York to Washington became rather involved, and the matter was finally left to the board of directors which will investigate the situation thoroughly and obtain an expression of opinion from the members as to the advisability of moving the headquarters.

Of Interest to Members

Buffalo Engineers Honor Roswell Farnham

At the May meeting of the Engineering Society of Buffalo, Roswell Farnham was elected President.

Mr. Farnham is a member of the Society's Council and makes his home in Buffalo where he is in charge of sales for New York state and vicinity for the Buffalo Forge Co.

After leaving college he specialized in the heating and ventilating field and during his business career has been active in organization work, serving as secretary and president of the Western New York Chapter of the A. S. H. V. E., and he has also held the offices of secretary and now president of the Buffalo Engineering Society.

Kansas City

May 5, 1930. This meeting, which was held at the Newbern Hotel, was combined with the meeting of the Engineers' Club for the purpose of inviting Dean F. Paul Anderson to address the joint meeting and so reach the largest possible interested audience.

After dinner all business was dispensed with and Dean Anderson addressed the 84 men present on the subject of the *Aristocracy of Engineering*. The appreciation expressed by the gathering was significant in that it indicated the possibility of securing attractive speakers by combining meetings with those of other organizations.

Southern California Chapter Organized in Los Angeles

At the Council Meeting in Minneapolis, June 24, unanimous approval was voted on the petition for a charter presented by Southern California members of the Society.

On June 12, a dinner meeting was held at the Commercial Club, Los Angeles, with 37 men in attendance. This meeting resulted from a call sent out June 7 by the Society members who signed the charter petition for the Southern California Chapter and the splendid response to this invitation indicates a strong local organization in Los Angeles.

The meeting was opened by Edwin C. Evans, acting as secretary for the Committee, who presented a letter of greeting from President L. A. Harding, Buffalo, and a telegram from the secretary, A. V. Hutchinson.

The ideals and aims of the Society were presented by Mr. Evans, who traced the growth of the organization from its early days to the present, and gave an outline of the scope of its activities.

Robert L. Gifford acted as temporary chairman and welcomed the assembled group, and expressed the hope that an active Chapter of the A. S. H. V. E. would soon be in operation in Los Angeles.

He commended the work that had been done by Mr. Evans in bringing together such a large number of the leading men in the heating and ventilating profession, and stated his conviction that a Southern California Chapter would have a rapid growth.

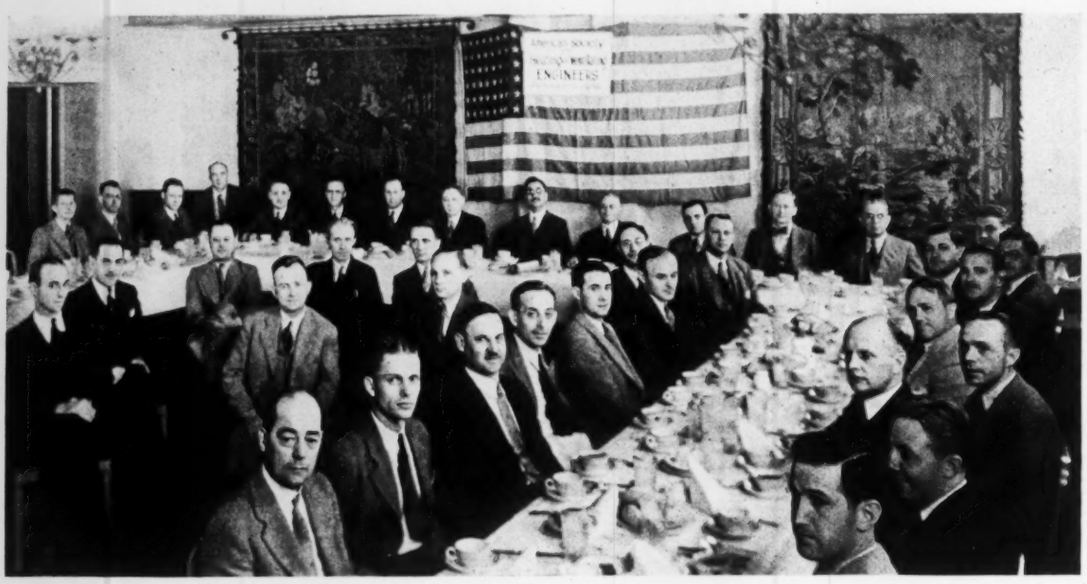
Until the petition of the charter had been acted upon the selection of temporary officers was in order and as a result of the vote of those present, O. W. Ott was elected chairman and H. B. Keeling was elected secretary. Mr. Ott expressed his appreciation for the honor of being chairman and assured the men present of his desire to be of the utmost service.

By action of the meeting the Committee consisting of C. S. Anderson, F. H. Hilliard and P. J. Dougherty was appointed to prepare a letter to the Council authorizing Mr. Evans to express the desire of the men present that a charter for a Southern California Chapter be granted.

Those present voted that the chairman appoint a Committee of three to select a suitable meeting place and suggest the time for meeting and the idea of having nine meetings a year, monthly except during the summer, was favored.

Mr. Evans announced that a Society member from Australia, C. C. Sands, visiting in Los Angeles, was absent because he was convalescing from an operation, and upon the proposal of Harrold English it was voted to send some flowers to Mr. Sands.

A rising vote of thanks was given to Mr. Evans for his untiring efforts to effect the organization of the Southern California Chapter of the A. S. H. V. E. The meeting then adjourned.



A. S. H. V. E. Members and Guests at Meeting in Commercial Club, Los Angeles, June 12, 1930

P. D. Junior

A potential engineer arrived on this hot planet, July 20, in the person of Paul D. Close, Jr., who was pleased to advise his unseen audience that Technical Secretary Paul D. Close, his father and Mrs. Close, his mother, are doing as well as any new parents are expected to do.

When interviewed at Lawrence Hospital, Bronxville, N. Y., P. D. Jr. said that it was evident that he would be a heating engineer, but with existing conditions might go in for temperature control or even air conditioning. For recreation he had decided to take up golf.

His proud father, when asked for specifications on the new arrival, said that at the age of one day, Junior weighed 7¼ lbs., had an overall length of 19.9625 in., circumference 10.1 in. and Btu output was 100%.

Death of John T. Bradley

The heating industry lost one of its well-known figures in the death of John T. Bradley in St. Louis, July 13, at the age of 71.

Mr. Bradley was born June 11, 1859, in St. Louis and attended the grade and high schools of that city. He served his apprenticeship in the heating industry in St. Louis, Mo., and Denver, Colo., and gained practical experience in St. Louis and Chicago. He organized the firm of Bradley & Creighton in Denver and in 1896 returned to St. Louis and organized J. T. Bradley & Co., which in 1905 became a corporation known as the Bradley Heating Co. The firm specialized in heating, ventilation and power plant installations and had many notable jobs to its credit not only in St. Louis and vicinity, but in other states.

In 1908 Mr. Bradley joined the A. S. H. V. E. and took an active part in its work, serving on the Board of Governors in 1911. He was an active member of the *Heating and Piping Contractors National Association* and for the past 25 years had not missed a single national convention. At the meeting in New York in June, he carried out his accustomed duties as Sergeant-at-Arms and greeted a great host of friends. He served as president of the national association in 1914 and 1915 after having been on the Board of Governors since 1908. For many years Mr. Bradley was president of the Vandeventer Trust Co. and was a member of St. Louis Lodge, No. 2, B. P. O. E.

The Officers and Council of the Society learn with regret that one of its Life Members has passed on and extend their sympathy to Mr. Bradley's widow and two sons, Eugene P. Bradley and John T. Bradley, Jr., who survive.

Death of Jack B. Morris

The tragic death of Jack B. Morris, Detroit, Mich., who lost his life by drowning, Sunday, July 6, has been reported by Secretary Clark of the Michigan Chapter.

Mr. Morris was with the firm of John A. Green, Detroit, heating contractors and had been in the service of that concern for the past five years. Mr. Morris was born at Tilbury, Ontario, May 31, 1906. Since leaving school he had devoted his business career to heating and ventilating work. Mr. Morris has a host of friends in the Michigan Chapter who will greatly miss him.

He was one of the newer members of the Society having joined during 1930 and the Officers and the Council extend to his widow, a sincere expression of their sorrow for Mr. Morris' untimely death.

Death of Samuel C. Parter

Word has recently been received of the death of Samuel C. Parter of 865 West End Ave., New York City. Mr. Parter was Secretary of James H. Merritt & Co., 207 Water St., New York City, well known engineers and contractors, specializing in steam and hot water heating.

Mr. Parter was elected to membership in the Society in 1907 and had spent his entire life in the heating and ventilating industry. He was born in Russia January 22, 1885, and after finishing grade and high schools, received his technical education at Cooper Union and Columbia University, New York City.

His first work in heating and ventilating was with A. McGonagle, and later with Fuller and Warren Co., New York.

The Officers and the Council deeply regret the passing of one of the Society's loyal members and extend their sincere sympathy to his business associates and his family who survive.

Death of James J. Mason

As a result of acute attack of bronchitis, James J. Mason died at his home in Cleveland Heights, Ohio, after a short illness at the age of 65 years. Mr. Mason had spent 40 years in the heating industry and had been associated with several well-known firms during that period.

He was born January 16, 1865, in Derby, England, and after receiving his schooling served as an apprentice with the Midland Railroad Co. After coming to the United States, he was with the New York Steam Heating Co., for several years and then did sales work for the Pittsburgh Gage and Supply Co. and the Standard Gage Mfg. Co. For five years he was with Chafer and Becker Co., steam heating contractors, Cleveland. Later he represented the Richmond Radiator Co. in Cleveland, served as Cleveland District Manager for the Utica Heater Co., and then represented the National Radiator Corp. in Cleveland until 1929. At the time of his death he was special representative for the Buckeye Blower Co.

During his long connection with the heating industry, Mr. Mason had developed a very wide acquaintance and as he was always an enthusiastic Society member he had a large circle of friends in the organization who will mourn his death. He was prominent in Chapter work and was recently elected a member of the Board of Governors of the Cleveland Chapter.

At the time of his death Mr. Mason was survived by a widow, Annie E., and a son and daughter, J. A. Mason, Elyria; and Mrs. G. Flor, Cleveland, to whom the Officers and Council extend their sincere sympathies.

Death of Wm. A. Russell

After an illness of ten days William Arthur Russell of W. A. Russell & Co., New York, inventor and manufacturer of steam heating specialties, died unexpectedly in St. John's hospital, Yonkers, N. Y., June 20 in his 68th year. Through the death of Mr. Russell, the Society loses one of its Charter members and the industry has lost one of its pioneers.

Mr. Russell was born February 2, 1863, and was educated at Columbia University and the College of Physicians and Surgeons. In 1888 after finishing the study of medicine he entered the employ of Bramhall, Dean and Co. as draftsman. In 1889 he became a salesman for the Richmond Stove Co., Norwich, Conn., and later did sales work for Russell Wheeler & Sons, Utica, N. Y. In the design of boilers he served with both Boynton Furnace Co. and the American Boiler Co. and in 1894 started in business as a manufacturer's agent.

Since 1895 when he invented an automatic air valve and other steam heating specialties, he has been actively engaged in the manufacture of automatic air and vacuum valves.

While Mr. Russell had retired from active business he retained his keen interest in the development of the heating and ventilating industry up to the time of his death. To his widow and three children the Officers and Council offer their sincere sympathy.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the name of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Membership Committee as soon as possible.

When the Membership Committee has acted favorably upon a Candidate's application and assigned his grade the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 41 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned. All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by August 11, these candidates will be balloted upon by the Council. Those elected to to membership will be notified by the Secretary, immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ARMITAGE, JOHN BARNUM, Engr., Austin Co. of California, Los Angeles, Calif.	A. H. Berg E. C. Evans	H. G. Thomas F. C. Houghten
BARKER, CHARLES M., Office Mgr., The B. F. Sturtevant Co., Los Angeles, Calif.	E. C. Evans A. H. Berg	F. C. Houghten J. D. Cassell
BAILEY, JAMES LUTHER, Engr., Parks-Cramer Co., Charlotte, N. C.	R. H. Brown A. F. Karlson	Howard Morrison *(ASME)* W. B. Hodge *(ASTM)*
BINFORD, WILMER MERRIMAN, Contract Mgr., Southern Asbestos & Magnesia Corp., Los Angeles, Calif.	E. C. Evans A. H. Berg	H. G. Thomas J. D. Cassell
BOUEY, ANGUS J., Sales Engr., B. F. Sturtevant Co., Los Angeles, Calif.	E. C. Evans A. H. Berg	H. C. Murphy F. D. Mensing
BRADFIELD, PAUL EDGAR, Sales Engr., Crane Co., Los Angeles, Calif.	O. W. Ott L. H. Polderman	J. D. Cassell P. J. Dougherty
BREMSER, HARRY A., Sales Repr., Hoffman Specialty Co., Los Angeles, Calif.	F. W. Wandless O. W. Ott	E. C. Evans P. J. Dougherty
BROWN, W. MAYNARD, Asst. Sec'y., Warren Webster & Co., Camden, N. J.	Warren Webster, Jr. C. G. Binder	J. D. Cassell W. T. Jones
CAMPBELL, RAY W., Sales Engr., L. J. Mueller Furnace Co., Milwaukee, Wis.	A. H. Berg E. C. Evans	F. D. Mensing W. A. Rowe
CLANCY, GILBERT EUGENE, Gay Engineering Corp., Los Angeles, Calif.	E. C. Evans A. H. Berg	J. D. Cassell F. C. Houghten
ESSER, FRED WILLIAM, Mgr., Refrigeration Div., Marine Engineering & Supply Co., Wilmington, Calif.	A. H. Berg E. C. Evans	J. D. Cassell F. C. Houghten
FOY, ARTHUR T., Engrg. Dept., National Biscuit Co., New York, N. Y.	A. S. Lau D. M. McKelvey	A. F. Hinrichsen Arthur Ritter
FRASIER, WILLIAM P., Student, Carnegie Inst. Technology, Pittsburgh, Pa.	S. E. Dibble C. O. Peterson	K. E. Johnson E. N. Pettit, Jr.
GARNEAU, LEO, C. A. Dunham Co., Ltd., Toronto, Ont., Can.	G. L. Wiggs C. A. Thinn	M. S. Good M. D. Pence
GUNZEL, RUDOLPH MILTON, R. M. Gunzel & Co., Los Angeles, Calif.	Warren Webster, Jr. E. C. Evans	W. F. Bilyeu C. G. Binder
HILLIARD, FORREST H., Sales Engr., U. S. Radiator Corp., Los Angeles, Calif.	O. W. Ott E. C. Evans	J. D. Cassell F. C. Houghten
HORTON, GEORGE H., Asst. Supt., Howe Bros., Los Angeles, Calif.	L. H. Polderman O. W. Ott	H. G. Thomas F. C. Houghten
HUNGERFORD, LEO, Chief Engr., Fox West Coast Theatres, Los Angeles, Calif.	E. C. Evans A. H. Berg	F. C. Houghten J. D. Cassell
JOHNSON, ARTHUR R., Crane Co., Los Angeles, Calif.	A. H. Berg E. C. Evans	J. D. Cassell F. C. Houghten
KEELING, HARRY BEAUFORD, American Blower Corp., Los Angeles, Calif.	O. W. Ott E. C. Evans	A. H. Berg J. D. Cassell
KIESLING, JUSTIN A., Geo. J. Robischung, Inc., Houston, Tex.	H. M. Hart J. L. DeNeille	J. S. Jung R. C. Beverly

KNECHT, CHARLES H., Mgr., Harry Knecht Co., Inc., West Collingswood, N. J.	A. J. Nesbitt Karl Rugart	J. J. Nesbitt
KRATZ, ROBERT WAYNE, Paramount Famous Lasky Corp., Hollywood, Calif.	E. C. Evans A. H. Berg	F. C. Houghten J. D. Cassell
LAMONTAGNE, JOHN M., Sales Engr., Westinghouse Elec. & Mfg. Co., Los Angeles, Calif.	E. C. Evans A. H. Berg	F. C. Houghten J. D. Cassell
LAWLER, MATTHEW M., Chief Engr., Cooling and Air Conditioning Corp., Los Angeles, Calif.	W. L. Fleisher C. H. Currier	E. C. Evans H. G. Thomas
Lees, William Douglas, Chief Electrician, Htg. & Vtg. Engr., Provincial Government of Alberta, Edmonton, Alberta, Canada.	Alex Walker H. D. Henion	M. B. Watson H. H. Angus
LEWIS, MILTON, Sales Engr., Southwestern Engrg. Co., Los Angeles, Calif.	E. C. Evans A. H. Berg	J. D. Cassell
MARQUET, CLYDE M., Vice-Pres., Pacific Engrg. Co., Los Angeles, Calif.	E. C. Evans A. H. Berg	J. D. Cassell F. C. Houghten
MARSCHALL, PETER J., E. Vernon Hill Co., Chicago, Ill. (*Advancement*).	E. V. Hill A. L. Weixel	H. G. Kreissl
MCCLELLAND, HARVEY SLOAN, Htg. & Vtg. Contr., Los Angeles, Calif.	E. C. Evans A. H. Berg	J. D. Cassell H. G. Thomas
MUELLER, PAUL G., Secy. & Treas., Pacific Engrg. Co., Los Angeles, Calif.	H. G. Thomas E. C. Evans	A. H. Berg J. D. Cassell
NELSON, J. FRED, Contract Mgr. & Estimator, Southern Asbestos & Magnesia Corp., Los Angeles, Calif.	J. G. Goodsill—*Non-Member* W. A. Dunn—*Non-Member* W. J. Dolph—*Non-Member*	E. R. DeGraf—*Non-Member* E. C. Evans P. J. Dougherty
OREAR, ANDREW GIBBS, Mgr., Pacific Coast District, Ilg Elec. Ventilating Co., Los Angeles, Calif.	A. G. Sutcliffe L. H. Polderman	H. G. Thomas F. C. Houghten
RICH, CALVIN GEORGE, Branch Manager, Berg Engrg. Corp., San Diego, Calif.	E. C. Evans A. H. Berg	F. C. Houghten J. D. Cassell
RIEGER, FRED R., Berg Engineering Corp., Huntington Park, Los Angeles, Calif.	E. C. Evans A. H. Berg	H. G. Thomas J. D. Cassell
SCHOURUP, WALTER EDWARD, L. J. Mueller Furnace Co., Milwaukee, Wis.	A. H. Berg O. W. Ott	E. C. Evans J. D. Cassell
TILTZ, BERNARD E., Pres., Tiltz Engrg. Co., New York, N. Y.	R. D. Tyler W. G. Kreitner	W. R. Zuhlke Bernhard Goerg
UPDEGRAFF, LEE, Sales Engr., 405 So. Hill St., Los Angeles, Calif.	O. W. Ott H. G. Thomas	J. D. Cassell P. J. Dougherty
WARD, ROBERT N., Engr., Tiltz Engrg. Co., New York, N. Y.	R. D. Tyler W. G. Kreitner	W. R. Zuhlke Bernhard Goerg
WARREN, HARRY L., Heating Engr., Southern California Gas Co., Los Angeles, Calif.	E. C. Evans A. H. Berg	F. D. Mensing W. A. Rowe
WEAVER, JOHN ROSWELL, O. W. Ott, Los Angeles, Calif.	O. W. Ott E. C. Evans	F. C. Houghten J. D. Cassell

Candidates Elected

In past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Membership Committee and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. II, Sec. VIII, of the By-Laws, the following list of candidates elected:

MEMBERS

ALGREN, AXEL B., Instructor in Mech. Engrg. & Asst. Dir. of Exp. Eng. Labs., Univ. of Minnesota, Minneapolis, Minn.

ANDERSON, CARROLL SIMMS, Mgr., American Blower Co., Los Angeles, Calif. (*Reinstatement.*)

CARTIER, CHARLES ERNEST, JR., Scott Stores, Inc., Chicago, Ill.

EWALD, WARREN, Experimental Engineer, John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa.

HENRY, ALEXANDER STEWART, JR., Mech. Engr., Radio Keith Orpheum Corp., New York, N. Y.

KILPATRICK, WILLIAM SQUIERS, Ch. Engr., H. S. McClelland, Los Angeles, Calif. (*Reinstatement.*)

LEWIS, CARROLL E., President, The Lewis Corp., Inc., Minneapolis, Minn.

MELONEY, EDWARD J., Bowers Bros. & Co., Philadelphia, Pa.

ORMSBY, H. KINGSLEY, JR., Hoffman Specialty Co., Waterbury, Conn. (*Advancement.*)

ROCKHOLD, KENNETH EDWARD, Mech. Engr., Austin Co., Newark, N. J.

SHIVERS, PAUL F., Chief Engr., Minneapolis-Honeywell Regulator Co., Wabash, Ind.

STOEVER, GEORGE H., John J. Nesbitt, Inc., Holmesburg, Philadelphia, Pa.

ASSOCIATES

GREEN, ROBERT F., Kelsey Heating Co., New York, N. Y.

MILLER, BRUCE RINKER, Sales Engr., Federal Steam Specialties Co., Oklahoma City, Okla.

SEBREE, GEORGE M., Carrier Engrg. Corp., 850 Frelinghuysen Ave., Newark, N. J.

ZIMMERMAN, ALEXANDER H., Research Engr., E. Vernon Hill Co., 121 N. Clark St., Chicago, Ill.

JUNIORS

GORDON, ROBERT H., American Carbonic Mchy. Co., Detroit, Mich.

LEACH, THOMAS F., Htg. Engr., Philadelphia Electric Co., Ardmore, Pa.

STUDENTS

CHANDLER, CLARK W., Student, Carnegie Institute of Technology, Pittsburgh, Pa.

CORRIGAN, JAMES ALOYSIUS, Student, Carnegie Institute of Technology, Pittsburgh, Pa.

HAYMAN, A. EUGENE, JR., Student, Carnegie Institute of Technology, Pittsburgh, Pa.

Heating · Piping and Air Conditioning EDITORIALS

Promotion of Economy Means Profit

That which is economical is inherently right, and consequently those who promote economy (and achieve it) should receive benefits due to its promotion. It is sometimes difficult to see how everyone may benefit from a strict economy program, when consumption of certain materials is cut down. Consider, for instance, the case of the district heating company, desirous of selling as much steam as possible, yet actively interested in educating its customers to operate their heating systems in a manner which will decrease the customers' steam consumption.

Aside from the good-will (which, of course, has a monetary value), the district heating company reaps an additional benefit from such heat utilization work, according to Sterling S. Sanford of the Detroit Edison Company in a paper presented before the annual meeting of the *National District Heating Association.*

"Heat utilization work does not greatly affect plant investment," according to Mr. Sanford. "Investment is determined by the demand in the coldest weather likely to be encountered. In such weather, maximum demand is but little affected by customers shutting off steam at night because they do not then practice this form of economy extensively. On the other hand, utilization work smooths out the peaks in the load curve because buildings, in following advice to turn off steam at night and keep it turned off as long as possible in the morning, tend to turn on steam at different hours according to the needs of the different classes of buildings."

Mr. Sanford further explains that showing customers how to economize decreases distribution system fixed charges per unit of steam sold because the new business which is attracted can be served from existing mains, as the mains usually have extra capacity for future business. Thus, through heat utilization work, or the promotion of economy, district heating companies may expect to profit.

It seems a similar analysis would show that increased profits for any concern or individual is the reward for the promotion of economy in the operation of heating, piping, and air conditioning equipment.

A Clean Boiler Room

John Howatt, chief engineer of the Chicago public School system says:

"You seldom find a white bird in a blackbird's nest. You seldom find a first-class man in charge of a dirty boiler room. The condition of the boiler room is as true an index of the character of the man in charge as the weather cock is of the wind. A dirty boiler room may be unimportant in itself, but it indicates a lack of pride in the work that is certain to be reflected in the care given the entire plant, and that is important."

Is there any real advantage between a clean boiler room and a dirty, slovenly one? No one can calculate just what an owner saves by having a shipshape boiler room any more than can any shipping man say how much loss results in not keeping a vessel right up to the mark. There may be no direct financial loss in the boiler room itself due to dirt, but it gives sufficient grounds for suspicion that there may be considerable losses throughout the plant.

Coal certainly can be fired just as efficiently in a dusty, dirty boiler room as in one that is scrupulously clean. It may burn just as well in the furnace and give off the same quantity of heat under the same conditions of combustion. The effect is not on the fuel or combustion, but if the boiler room is dirty isn't it within the bounds of reason to assume that the boiler tubes and flues are also dirty, and that very materially affects the efficiency of the boiler plant.

And how about the personnel? It has been found to be true in a hundred instances that the condition of the boiler room is an indicator of the condition of the remainder of the building. A high class building, well-supervised and carefully looked after, will nearly always be found to have a clean, orderly boiler room. On the other hand, a building which largely runs itself and has untidy halls and dirty walls, usually runs true to form in having a terrible boiler room, usually located in a dark spot, inconvenient and full of rubbish and dirt. The effect of a clean boiler room is not so much directly on the equipment as it is indirectly through the personnel and its effect on it. The fireman, engineer, custodian, or whatever the title may be of the man who is responsible for the boiler room, either keeps it in

proper shape through pride or because of periodical inspections by some one higher in authority. If the boiler room is dirty, therefore, it indicates either a lack of proper supervision or a lack of pride on the part of the operator, or both.

If the operator has no pride, he has no ambition. With no ambition any job is bound to suffer. Lack of ambition on the part of those in charge of the mechanical plant has a more direct bearing on the efficiency of the work than almost any other kind of employment. Here then is a financial loss to the owner, due, indirectly perhaps, to a slovenly operator, for the unkempt boiler room is certain to be a part of a plant with a pipe system full of leaky fittings and valves, glands needing packing, pipe covering partially falling off, rust and corrosion making inroads due to lack of painting, apparatus partially out of repair, gaskets on flanges leaking and so on ad infinitum. It all goes together, slipshod indifferent methods in the boiler room and slip-shod indifferent care throughout the rest of the installation.

Give all credit to the operator who keeps his boiler room and his installation up to the highest standard and makes it his pride. The man who is thorough is bound to be thorough all the way through from the boiler room floor to the last nut on the bolt in the most distant piece of equipment.

"Dry Humidity"

"Air conditioning will not come into its fullest use," said an air conditioning engineer the other day, "until the average citizen is better acquainted with its advantages, characteristics and equipment. There are few persons, for instance, who do not have a fair idea of the mechanism of the automobile. When air conditioning is as familiar as the structure of the automobile is to the average person, air conditioning will be desired by managers and owners of practically every large hotel, hospital, apartment, office building, factory or other large structure in the country."

An interesting story told a few days ago by one of the engineers of an eastern air conditioning manufacturer serves to illustrate this.

"While in San Francisco recently," said this engineer, "I had occasion to discuss with the owner of a manufacturing plant the necessity of air conditioning equipment for several of his processes.

"The owner inquired just what benefit would be obtained by such an installation. He was informed that it would reduce the relative humidity within these departments. He then calmly announced that they had no humidity in San Francisco."

It so happened that the engineer had taken a psychrometric reading about an hour previously and found that at that particular time there was indicated 85 per cent relative humidity and he told the factory owner of this condition. His reply was, "Well, there may be a lot of humidity in San Francisco, but it is dry humidity."

Heating, Piping and Air Conditioning is doing much toward giving to manufacturing plants a correct conception of air conditioning, its characteristics and its advantages.

Cooperation and Economy

—A Letter.

I read with interest the editorial in the July issue on the elimination of waste campaign.

It strikes me that such constructive articles on this subject are very timely. I venture to say that with so much stress being placed on reducing overhead in industry, and with competition becoming more and more keen, that industry will continue to cut waste wherever possible.

The building management group is making some headway in this respect. Of course the immediate need, after you realize that there is waste, is to secure facts. In the case of mechanical equipment, it is going to require more in the way of recording instruments and accounting so as to provide facts as to operating performance and cost, as well as the means of measuring savings.

Consider the school house group as a class. The mechanical equipment represents a considerable portion of the initial cost or investment, and after the building is completed, and the plant put into operation, the heating and ventilating system represents the largest single item of operating expense, with the exception of the teachers' salaries. It is quite obvious that with teachers' salaries more or less fixed, that in the operation of the heating and ventilating plant, there is afforded the greatest opportunity of saving in operating and maintenance cost.

You are familiar with the Government's activities during the war in forcing coal users to save in the amount of fuel used. As a simple example of this, a leaky boiler setting penalized the operator in the amount of coal allowed to him. Before he could secure the additional necessary fuel he was obliged to point up or otherwise make his setting tight. It seems as though in the matter of waste, like many other things that enter into our modern life, we are almost obliged to pass laws with penalties attached to require that we do those things which are for the best, not only for ourselves, but for others.

The only alternative to the passage of laws is education and other programs that induce or encourage individuals and concerns to be thoughtful and saving.

To bring about less waste in our field of endeavor, whether it be heating, piping, or air conditioning, it is essential that manufacturers, as well as designing and operating engineers, cooperate more closely in a spirit of service and saving.—*A Subscriber.*

PRACTICAL PIPING PROBLEMS

Preventing Losses through Traps
Drip Valves for Pumps and Engines
Waste in the Feedwater Heater

by
W. H. WILSON

Economies through Proper Installation of Piping

Loss of money, on account of waste, is found, more or less, in all industries and it is hard to eradicate. Piping equipment comes in for its share of loss by waste. The waste loss in heating, piping and power equipment is sometimes caused, in part, by not having the proper equipment. Mistakes are made in the selection of equipment that often lead to operating losses. Operating conditions change after equipment has been installed and different methods have to be used to get better results.

Maintenance men and persons in charge of operating equipment, however, can eliminate a large amount of waste by careful and proper use of existing equipment. Much depends on the maintenance man, as he is in a position to see and discover leaks and wasteful practices.

Good maintenance work frequently passes unnoticed. Men in executive positions at large industrial plants often take a questionable attitude in regard to the requirements of maintenance work.

The following is typical of many large industrial organizations: When a large steam line, water main or gas pipe breaks, everybody at hand extends his help and the pipe line is shut off and nothing stands in the way of prompt and speedy repairs. Telephones are busy, the purchasing agent places orders for the material by phone, if necessary, and through plant and shop co-operation, repairs are quickly made. The plant executive prides himself on a maintenance department that is on the job.

The truth of the matter may be, and this is not an exceptional case, that when a large pipe line breaks, a report, usually by telephone, is received promptly by the proper parties, and the less experienced mechanics in the repair department can do something to close the valves and make some kind of repairs, temporary or permanent, that will prevent the waste continuing.

Some "Money-Losing" Conditions

While this is going on there may be all the way from one to many more steam traps in the same plant that are blowing through and have been in this condition for months. The overflow for the boiler feed water heater may be sending a stream of hot water to the sewer. One or more cylinder drips on engines or pumps may be leaking. A pass-by for a steam trap or regulator may be leaking or carelessly left partly open. Oil lines, water lines, steam and other lines, in close, dark tunnels, probably have a number of leaks. All of these leaks and wasteful practices are not readily detected and as long as they are not visible, it is seldom that any one pays any attention to them. As long as the plant runs, with no large leaks being *visible,* every one seems satisfied.

A careful check will often show a large amount of costly waste from these sources. Steam traps blowing through, leaking boiler blow-off valves and boiler feedwater heaters are three factors in a large industrial steam plant that often cause costly leaks and wasteful operating conditions.

The problem of the plant officials is to prevent this loss and this can be accomplished more easily by providing convenient ways for determining whether the equipment is in proper working condition.

Preventing Losses through Traps

Steam traps should be provided with a try-out valve, open to the atmosphere, on the discharge side of the trap. It is good practice to put a swing check valve on the trap outlet or discharge pipe and place the try-out valve between the check valve and the trap. By opening the try-out valve, the operation of the steam trap can be observed and it can be readily determined when the trap is blowing through and wasting steam. This is a help on all traps and especially so when traps are located in places near machinery in operation, where noise makes it difficult to hear the steam passing through the valve seats of the trap.

Pass-by connections on steam traps may be necessary in some cases, but as a general rule they can be dispensed with, as far as the traps are concerned, and this eliminates one more chance for waste from this source. In large industrial plants, where there are a number of maintenance men, working different shifts, it is not an uncommon thing to find pass-by valves carelessly left open a few turns.

Another common practice is that steam traps are frequently installed in out-of-the-way places, in dark tunnels and basements that are not readily accessible. When traps are placed in these locations, the kind of maintenance service and inspection they get is just about what could be expected. Persons in charge of steam equipment will find it to their interest to see that traps are placed conveniently for inspection. It may take some more pipe and fittings to do this, but it will be money well spent, considering the extra attention that will be given the traps.

Leaking Boiler Blow-Off Valves

Boiler blow-off valves are a losing proposition when they are continually leaking. Keeping the blow-off valves in good condition depends largely on the operating man in charge and should not be difficult. Blow-off valves are usually accessible and with the convenient features of valves of the present day, repairs can be quickly and easily made. These valves should be used daily when the boiler is in operation; they have a hard service to

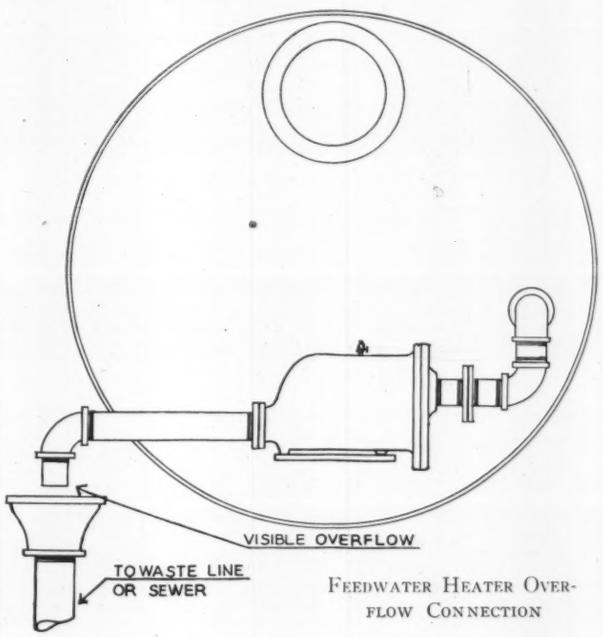
perform and require attention to keep them in good condition.

The careful operator will do his blowing-down with the outside valve and keep the valve next to the boiler in good condition. In this way, renewals of the valve disc and seat can be reduced and the valve kept in better condition.

It should not be hard to determine when the blow-off valve is leaking. Placing the hand on the blow-off pipe near the valve, will, by its temperature, tell whether or not the boiler is losing hot water.

Waste in the Feedwater Heater

The boiler feedwater heater, in a number of cases, is the cause of waste. This is a common occurrence in



FEEDWATER HEATER OVERFLOW CONNECTION

plants where a large amount of make-up water is used in connection with the return water from the heating system and steam process work. When the water controlling devices get out of adjustment, cases have been known where a stream of hot water was running out of the overflow pipe of the heater to the sewer for weeks at a time. (This is not to be confused with a skimmer pipe for a feed water heater that permits some hot water to waste from the heater, to eliminate the oil from exhaust steam used to heat the feedwater.)

The overflow pipe from a feedwater heater should discharge into an open pipe or funnel, before going into the sewer or waste water lines. With the overflow visible, any waste of water will be noticed promptly and steps naturally will be taken to correct the trouble.

A recording thermometer installed on a feedwater heater is a great help to the attendant and an incentive for careful and proper operation. In most cases it will be found to be well worth the cost of installation.

Drip Valves for Pumps and Engines

Cylinder drip valves for engines and pumps should not be connected to a header pipe with a solid pipe connection to the waste water drain pipes or sewer. Each drip valve should be open to the atmosphere, so that the drip outlet will be visible; then in case a drip valve is leaking, it can be quickly detected. When these drips are connected to a common header, with a continuous pipe connection to the sewer drain pipe, or below the floor line, these valves may leak for some time before they are detected and repaired. In the meantime, much heat and power is wasted.

Drips and overflows of all kinds, being visible, are naturally more promptly repaired, which in turn means a saving and economical operation.

Condensation from steam lines is pure distilled water and contains a large amount of heat. Getting this condensation back to the boiler with as little loss of heat as possible should be the aim of the person in charge. For this purpose, the pipe lines should be well-insulated and, if of any great length, should be of the smallest size of pipe that will consistently take care of the condensation in order that the water will reach its destination quickly with as little heat loss as possible.

Gas Pipe Survey

FEIN TIN CAN CO. is engaged in manufacturing tin cans. The metal, which comes in thin sheets, is cut and shaped to the specific can size by machines. The cans are then soldered at the joints by soldering irons heated in small gas furnaces, painted, and passed through a gas fired oven (of the overhead chain conveyor type) to dry and bake.

The finished cans are made on order for manufacturers of paint, ink and other commodities. They are made in varying sizes, from 2x2 in. diameter, to 12 in. high by 12 in. diameter.

The concern occupies a three-story building and is supplied with gas through a 3-in. service. The equipment includes cutting machines, soldering bench furnace, a tool hardening furnace and 40-ft. drying oven, the last three items using gas. The outlets in the gas line indicate that future expansion will include gas equipment.

Calculation of Pipe Sizes

In laying out the gas piping for this building, the first step was to determine the known factors:

1. Present gas demand—1500 cu. ft./hr.
2. Dimensions of building—164 ft. L. by 82 ft. W. by 45 ft. H.
3. Future gas demand—1500 cu. ft./hr.
4. Total gas demand—3000 cu. ft./hr.
5. Present location of industrial gas appliances.

With these factors in view, the next step was to determine the method of distribution.

The choice of one of two methods could be resorted to:

1. Running the main line from the service vertically to the third floor, on one end of the building (see Fig. 1) and tapping off from that line to the various points of demand on each floor, by means of headers.
2. Running the main line from the service horizontally along the length of the building on the first floor, to the center of the building, and from that point erect a vertical header to the third floor, from which branches could be tapped to the various points of demand on each floor.

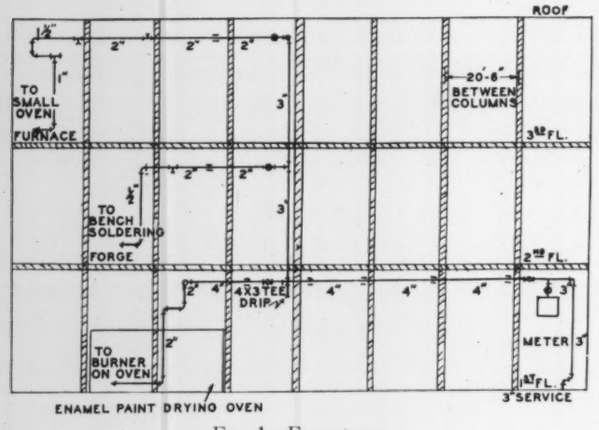


FIG. 1—ELEVATION

Of the two methods, the second was adopted because it was more feasible. In the first place, it involved less length of pipe and therefore reduced the cost, and secondly it created more uniform distribution on either side of the main header and lessened the drops in pressure due to shorter lengths of pipe.

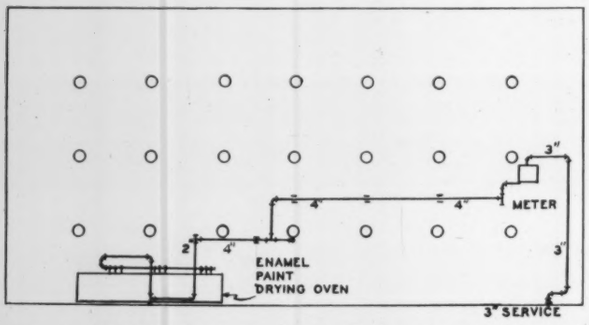
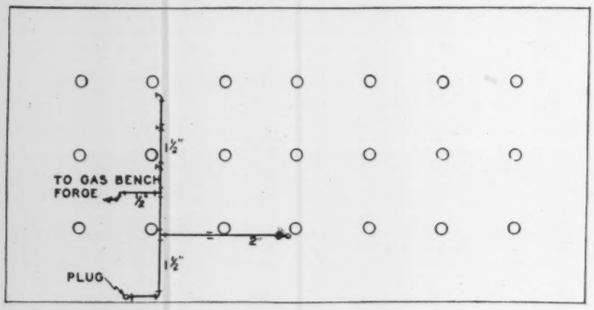


FIG. 2—(ABOVE) PLAN OF FIRST FLOOR. FIG. 3—(BELOW) PLAN OF SECOND FLOOR



The third step involved the determination of the sizes of pipe required. These sizes were arrived at by means of the "Low Pressure Flow Computer."

This computer is an indicating dial device, which gives the size pipe, length of pipe, flow of gas in cu. ft./hr., for pressure loss in inches of water, provided three of these factors are known. The calculations from which this indicator is made are based on Dr. Pole's formula for low pressure gas flow, as obtained from low pressure city mains:

$$Q = 1350 \sqrt{\frac{d^5 \times P}{\frac{L}{3} \times \text{spec. grav.}}}$$

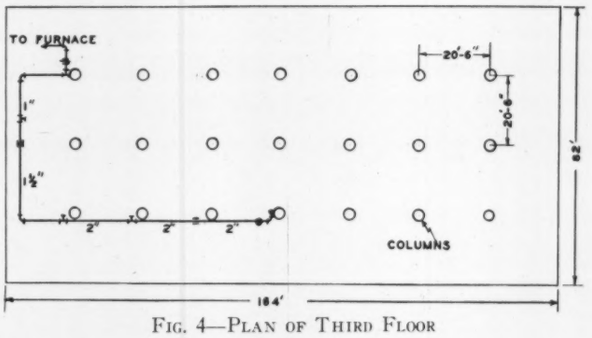


FIG. 4—PLAN OF THIRD FLOOR

in which

Q = cu. ft. of gas delivered per hour

d = diameter of pipe, inches

L = length of pipe, feet

P = loss of pressure through the pipe, and is the difference between the initial and final pressures, expressed in inches of water

Spec. grav.—In the case of city gas (550 Btu) it is assumed to be 0.6.

Referring to Fig. 1, the pipe sizes are as follows:

1. Service to end of main line; 1st floor; 0.2 in. drop in pressure; 3,000 cubic feet, 4 in. line required. The sub-service, from service to meter is 3 in. because of the short run from the service to the meter. (Main line 200 ft. long.)

2. Vertical header in center, 30 ft. long, to supply 2nd and 3rd floors. Takes ½ of demand, or 1500 cu. ft. No pressure drop (say about .03 in.); 3 in. pipe required.

3. Horizontal run to supply 1st floor to take ½ of demand, or 1500 cu. ft. 0.2 in. drop in pressure. 30 ft. of 2 in. pipe on four branches from main line supplies this floor.

4. Horizontal run to supply 2nd floor to take ¼ of demand or 750 cu. ft.; 0.2 in. drop in pressure. 50 ft. of 2 in. pipe on either side of header supplies this floor.

5. Horizontal run to supply 3rd floor to take ¼ of demand or 750 cu. ft. 50 ft. of 2 in. pipe on either side of header supplies this floor.—*J. P. Shotland,* Brooklyn Union Gas Co.

Conventions and Expositions

National Association of Power Engineers: Annual convention and exhibition, Sept. 8-13; Cleveland Auditorium, Cleveland, Ohio. Secretary, Fred W. Raven, 417 S. Dearborn St., Chicago.

National Metal Congress and Exposition: Sept. 22-26, Stevens Hotel, Chicago.

American Gas Association: Annual convention and exhibition, Oct. 13-17; Atlantic City Auditorium, Atlantic City, N. J.

Stoker Manufacturers Association: Nov. 11-13, Greenbrier Hotel, White Sulphur Springs, West Virgina.

National Association of Practical Refrigerating Engineers: Annual convention and exhibition, Nov. 11-14; Hotel Peabody, Memphis, Tenn. Secretary, E. H. Fox, 5707 W. Lake St., Chicago.

American Society of Mechanical Engineers: Annual meeting, Dec. 1-5; New York City. Secretary, Calvin Rice, 33 W. 39th St., New York City.

INTERVIEWS OF INTEREST

Fans and Pipes for Chemical Plant

The products of the Central Chemical Company, Calumet City, Illinois, are sulphuric, muriatic, and nitric acids, each offering a specific problem in process handling and plant hygiene.

The chamber process for the manufacture of sulphuric acid is employed. SO_2 gas is drawn from the burners by means of a fan and introduced into a series of lead chambers where oxidation through the medium of oxides of nitrogen is effected and where, in the presence of water, commercial sulphuric acid is formed. The gases are handled through brick and lead flues by special hard lead fans. The acid produced, and that used in circulation, is moved by corrosive-proof pumps and cast iron blow cases. Where the acid is concentrated, steel or iron pipe and fittings are used, while the dilute acid is handled in lead pipes.

Muriatic acid gas is handled in acid proof stoneware fume lines and absorption is effected in equipment and towers of the same material. The rubber lined steel fans are used to draw the gas through the absorption system. These fans are very satisfactory and are comparatively new in the industry. Circulation and delivery of the acid is effected by means of pulsometers with glass lines and rubber lined steel tanks fitted with hard rubber pipe. The use of rubber lined steel tanks with hard rubber pipe, also rubber lined steel pipe and fittings, offers satisfactory means of handling muriatic acid. Two such tanks perform the dual role of storage and means of delivery, as both are equipped for pressure delivery.

In the nitric acid plant the acid is handled through pipes of non-corrosive iron, stoneware and glass. Circulation of the acid is by pulsometers and corrosive-proof iron pumps. The movement of the gases through the absorption system is made possible by the use of corrosive-proof iron fans.

Sulphuric acid of high percentage is handled in ordinary iron pipes. Weak solutions of sulphuric behave differently and require lead piping, some non-corrosive iron, glass, or rubber.

The rubber coated fans utilized for muriatic acid handling will handle fumes up to and including 50 per cent at their boiling point without injury to the fan or other parts of the apparatus exposed to fumes. Housing and other construction details are so calculated that gas-tight installations endure for long periods. Exhaust fans are of lead, hardened with acid-resisting alloy, and balanced to operate without vibration. The gases are handled in closed systems.

"Reliance formerly was placed upon earthenware fans, but these are heavy and fragile if only slightly out of balance," states C. K. Clayton, plant superintendent. "Rubber lined fans, tanks and piping offer a highly satisfactory solution of our problem.

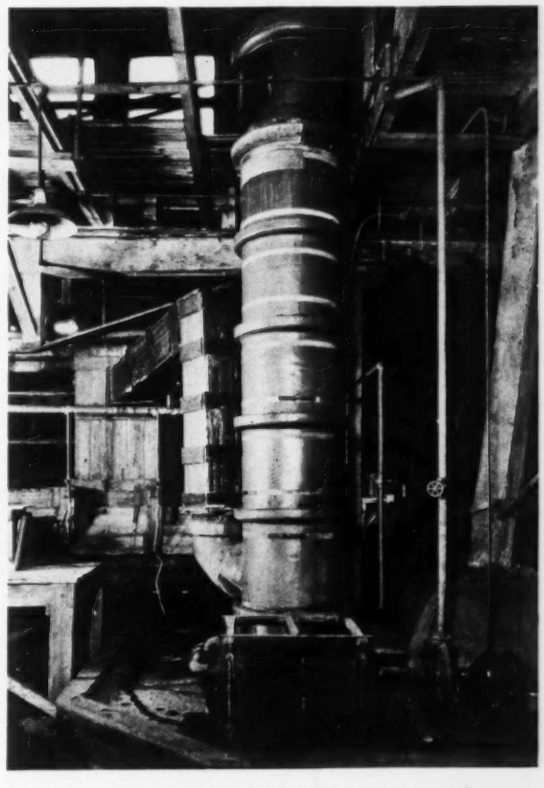
"It is a recent innovation with us to utilize steel, rubber-lined tanks and pipes and valves. This enables muriatic storage and distribution. One 10,000 gallon and one 2,000 gallon steel tank are used. Set low in a pit of concrete, they are filled by means of glass piping and gravity flow. Distribution and loading are effected by means of compressed air pressure through hard rubber pipes.

"Some of our hard rubber piping has been in use for many years and done hard service with small renewal or repair. The rubber lined valves are an especially useful departure in our plant."

"Piping arrangements within the chemical plant are highly standardized nowadays," states Mr. Clayton. "Time was when the average chemical plant jealously kept its portals closed and posted men at every entrance to keep any visitors away from the plant. But now engineers get together on their problems. They exchange their knowledge and best stunts, and every plant manager can utilize the newest wrinkle in his work. Pages of engineering journals are our tools and advertisers' technical announcements are an absolutely indispensable aid to progress in the plant."

Ventilation in Plating Processes

Unusual ventilation arrangements in the plant of the Acme Steel Company, Chicago, serve the double purpose of preventing air contamination of the work room by fumes of acids in the "pickling" process preliminary to



A Pump Beside the Tower Elevates the Water, Which Trickles Down, Absorbing Free Acid Gases